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The St. Louis Convention. As the time approaches for the gathering of the clans at St. Louis the interest in the convention increases. In accordance with our custom we commence in this issue a series of articles illustrative and descriptive of the electrical features of the convention city. The electrical developments in St. Louis are, taken all in all, perhaps more extensive than in any other city in the country, and cannot fail to be of interest to the visiting electricians who will congregate there on the last of this month. The arrangements for transportation from the East have not yet been completed, but will probably be announced in our next.

Litigation Rampant. THE recent announcement in the daily press of the country of the purchase from one Kelly of the Green electric railway patents by the General Electric Company, owing to the disturbed condition of the electrical industry, caused by the present lamp litigation, has given rise to more speculation than would ordinarily be aroused by a report of greater definiteness. It is claimed for the Green patents that they cover the use of the trolley as a means of conducting the current from the wire to the motor, and that all users of the trolley to-day are infringers. The owners of the Adams patents, who have already taken the aggressive in the courts, claim that all present methods of suspending the motors beneath the car are infringements, and the claims of the General Electric Company on the incandescent lamp are too fresh to require mention. With injunctions impending from all these directions where are we safe?

The Single Trolley vs. Telephone Abroad. OUR cable dispatch from London this week brings tidings of the first decision in the English courts of the question which so long agitated the electrical street railway and telephone interests in this country. It was the same old question as to whether the single trolley had a right to exist in the neighborhood of already existing telephone lines. As we understand it, our English cousins have fought it out on the same old lines with which we are so familiar and the decision followed closely on the precedents established here. It is rather a reversal of the usual order of things for America to establish precedents for the mother country, but as the precocious child not infrequently outstrips the parent in these days, it is not surprising that Young America should outstrip the old lady in things electrical. The fact that American rulings were frequently referred to is a compliment that our bar will appreciate, as much as will electricians the implied admission of our advanced position in the application of electricity.

Fluctuations and Storage at Central Stations. IN a recent paper by Prof. Unwin, which is abstracted in our Digest this week, he calls attention to the fact that the lack of efficiency in central stations is due largely to the fluctuations of the load, and that it could therefore be increased by applying some means of storing. This applies even more directly to power stations for railways. He shows that storage batteries are too unsatisfactory and expensive and that gas-holders are cheapest when gas engines are used. He then explains the method of storing hot water under pressure for generating steam, and gives his indorsement of the method as being practical and not requiring large plants. As he is a recognized authority we call special attention of central station managers to this, as it may play an important part in the future, especially as it is an apparatus which could be added to existing plants without radical changes. As it is not patentable central station managers need not fear that some years hence they will get into trouble due to some delayed and uncertain patent litigation.

The Duplication of Invention. IF the claims of Heinrich Goebel to having anticipated Edison in all that is essential in the incandescent lamp shall be decided to be well founded, it will add but another to the already long list of independent inventions by parties not conversant with the labors of each other. While indubitable instances of this kind are already quite numerous, they have most frequently resulted from an existing demand which has furnished the stimulus for the new creation. It is not strange, when we think of it, that like causes should produce like results, but we are, nevertheless, always startled when a new discovery is simultaneously announced from independent sources. Some one, in commenting on this not infrequent occurrence, said that he was convinced that the Lord never intrusted his greatest ideas to a single individual, but distributed them among several, so that the seed might be surer of finding fruitful soil. But a study of the history of invention goes far to show that the great strides that have marked its pathway have been the product of the times, and in retrospect seem as logical as any of the others which are accepted as but falling into their natural places in the sequence of events. An invention born out of due time is bound to wither and to die, and is only resurrected when the world has advanced to an appreciation of its need. Thus has arisen probably the saying of Solomon that "there is nothing new under the sun." Scarcely an invention of importance can be mentioned that there cannot be found somewhere in the past something that seems to be in a measure at least anticipatory, but the remarkable feature of the question under discussion is that the invention of Goebel, if it is proved that it is his, though born out of time, has survived to fulfill in minutest particulars the finished product of more than a generation later. According to the story of Goebel he had produced a finished product before the means for utilizing it or a reason for its existence had arisen. No one claims that Edison was not original or that he copied his lamp from earlier workers, and whatever the decision of the courts of last resort he will be equally entitled in the abstract to the credit which is given him.

The Incandescent Lamp Situation. AS announced elsewhere, both parties to the suit now pending before Judge Colt appeared last Wednesday and submitted their briefs and affidavits, and the evidence is now all in and under consideration by the court. As stated in our last issue, the burden of the proof in the remarkable defense offered by the Beacon Vacuum Pump and Electric Company lies with that company, and the impression formed from the affidavits and arguments then presented was not favorable to the defense. Some of the difficulties that had to be met were then pointed out, and it was our opinion that the defense had not fully met them. Those whose business it is to weigh testimony know that mere preponderance avails but little, and that often a single unsupported fact entirely isolated, it may be, from the mass of testimony offered, will outweigh the concurrent testimony of many, or make impregnable a case otherwise weak. It seems to us that such a fact was offered by the defense in the additional affidavit of Heinrich Goebel last Wednesday in the statement that absolutely pure mercury would not form an amalgam with copper. If this were a fact it was one not known to chemists, and must have been discovered by Goebel himself. That it was not known in the arts Goebel did not seem to be aware himself, and his announcement of the fact was only drawn out by the doubt cast on the date of one of the exhibits by the absence of such an amalgam in an exhibit said to have been made with a Torricellian vacuum. The testimony of Pope that experiments had proved that Goebel was right lends credibility to many of his other statements that previously lacked the requisite support to give them weight. While this simple statement would not at first sight seem to have any direct bearing on the point at issue, it has on closer examination a deeper significance. If this fact were not known to those skilled in the handling of copper and mercury, and had not found its way into the literature of that day or of this day either, its discovery must have been the result of experiment in the direct line in which Goebel claims to have been working at the time. And thus a missing link, necessary to the credibility of the testimony relied upon by the defense, was most unexpectedly supplied. In direct line with this new evidence is that of the several witnesses who state that when Goebel was first employed by the American Electric Light Company he was already skilled in the art of making carbon filaments and sealing them into glass tubes. This also adds strength to his claim that he had previously worked on similar jobs. The affidavit of Perkins, who for some time had been engaged in the attempt to manufacture incandescent lamps, while open to the accusation of being furnished by an interested party, brings out what the profession have long known, viz., the jealousy with which lamp manufacturers then and still guard the secrets of their trade. If one whose whole time and thought were devoted to the subject of incandescent lamps had never been able to see any but those of his own manufacture, it seems improbable that another in Goebel's position could have become so familiar with all the secrets to success as he seems to have been at that time in any other than the way claimed. Thus step by step have the defense woven a web of probability around the claims of their chief witness, that the exhibit of the Goebel lamp No. 4 with its hairpin filament in an existing vacuum and platinum leading-in wires, and the exhibits of the various planing machines alleged to have been made and used by Goebel for shaping and reducing his filaments, important as they are by themselves, seem only minor links in the chain. While the testimony of those who worked with Goebel for the American Electric Light Company that he did make carbons superior to those that company had previously been able to make is offset by other witnesses who claim that he did not, and the prosecution present affidavits from familiars and neighbors of Goebel who frequently saw his telescope wagon, but not his electric lights, the prosecution are placed by the evidence in the peculiar position of being on the defense, and relying for this part of the case, at least, on purely negative testimony. The claim of the prosecution, too, that this evidence is old, that it was investigated by them in years gone by and discarded as unworthy of attention, while at first it seemed strong, is likely to prove a boomerang and to do them more harm than good. This and other developments in the case seem to have clearly placed them on the defensive and they can no longer brush aside the opposition as trivial. We were struck with the weakness of the arguments of counsel for the prosecution at the hearing two weeks ago, but attributed it solely to the surprise which was sprung upon them. It may now be in order for them to explain why they were surprised if they knew of this testimony beforehand, else their claim that it is old must fall. Should the temporary restraining order be denied, as now seems probable, both sides will come to the final trial more fully prepared than now, and a fight to the death will follow that will doubtless go down to history as one of the most remarkable in the annals of patent litigation.

Decision in the Case of the National Telephone Company vs. Graff-Baker.

(By Cable from Our Own Correspondent.)

A decision has at last been reached in the action of the National Telephone Company against Mr. Graff-Baker to restrain him from so running his electric cars at Leeds as to interfere with the ordinary use of the telephone, which had been established for a great many years at that place. The verdict is for the defendant and in favor of electric traction, and the Judge was largely influenced by the excellent American decisions upon the same question. It is thought that the testimony of Mr. O. T. Crosby and other experts from the United States had an important bearing upon the results of the case. There has been a great variety of testimony in this important case, Lord Kelvin and Dr. John Hopkinson, on behalf of the plaintiffs, testifying that the disturbances were in many cases such as to prevent the everyday use of the telephone wire. On the other hand, Mr. James Swinburne and M. Abdank Abakanowicz stated that the disturbances were noworse than the London telephone subscriber was daily accustomed to.

Heating Effects of Alternating Currents.

BY A. D. LUNT.

In an article on the "Alternating Current Ampere" in The Electrical World of Jan. 7, the definition of an alternating current is given in terms of its heating effects, this being thought simpler than by defining it as the square root of the mean square of the current strength. To quote from the article in question: "The amperage of an alternating current is equal to that of a constant current when the heating effects of the two currents passing through equivalent resistances are the same. If the resistance is constant and non-inductive, the heating effect measures the whole energy expended and is proportional to the square of the current, and when the latter is constant is very easily calculated." While, as a matter of fact, this ease of calculation is true in the case of continuous currents, the aspect of the case changes when we come to deal with alternating currents, and we cannot even take the resistance of the conductor the same as for continuous currents. This point may be illustrated by some experiments suggested by Dr. Bedell, of Cornell University.

It is well known and has been investigated mathematically, that the resistance of a conductor to alternating currents is greater than to direct currents of the same value, and this is well shown by the accompanying curves, which were obtained from a hot wire ammeter by passing direct and alternating currents through the instrument and noting the corresponding readings. The abscissae of the two curves of Fig. 1 represent current in amperes, while the ordinates represent heating effects, which are measured in this case by the elongation of the heated wire. The upper curve is that due to alternating currents, and the lower curve represents the effects due to continuous currents of equivalent values as measured by a Thomson balance.

It will be noticed that for any given current the elongation of the wire and consequently the heating effects are greater for alternating than for direct currents, and that this difference is not a constant quantity, but varies with the current; so that if we say that a continuous current passing through a resistance is equal to an alternating current which produces the same heating effects in another conductor of equivalent resistance, we state a fact which is literally true, but which involves the question as to what the equivalent resistance may be in this case.

As a further illustration may be mentioned some calorimeter experiments performed by Messrs. Hale, Kelley and Hall, under the direction of Dr. Bedell.

The use of the calorimeter is simply another way of attacking the problem, and in brief is as follows: A continuous current with a certain constant value is sent through a coil of platinum wire inclosed in a water calorimeter, and the rise in temperature of the water, after certain intervals of time, is accurately measured. This operation is continued until a sufficient number of readings have been taken and the calorimeter is then allowed to cool off. A new start is then made with an alternating current of the same value as measured by a Thomson balance, readings being taken as before, and the current being kept at a constant value by means of a water rheostat, as was done in the first case.

The curves of heating thus obtained are shown by the solid curves in Fig. 2, in which the abscissae represent time measured from the moment of turning on the current, while the ordinates represent the corresponding temperatures in the calorimeter.

In order to correct for the heat radiation from the calorimeter a so-called cooling curve (not given here) was obtained, in which the rates of cooling at different temperatures were shown. Combining this curve with the curves of heating, we obtain curves showing the rate of heating if there were no radiation or loss of heat. The change in resistance due to temperature, being but a small portion of one per cent., may practically be neglected, so that we have as a result the dotted curves in Fig. 2. These are practically straight lines and represent the rate of expenditure of electric energy in heating the conductor. Since the expenditure of electric energy is proportional to the product of the square of the current and the resistance, and since the square of the current strength is the same for each curve whether the current be alternating or continuous, the rate of transformation

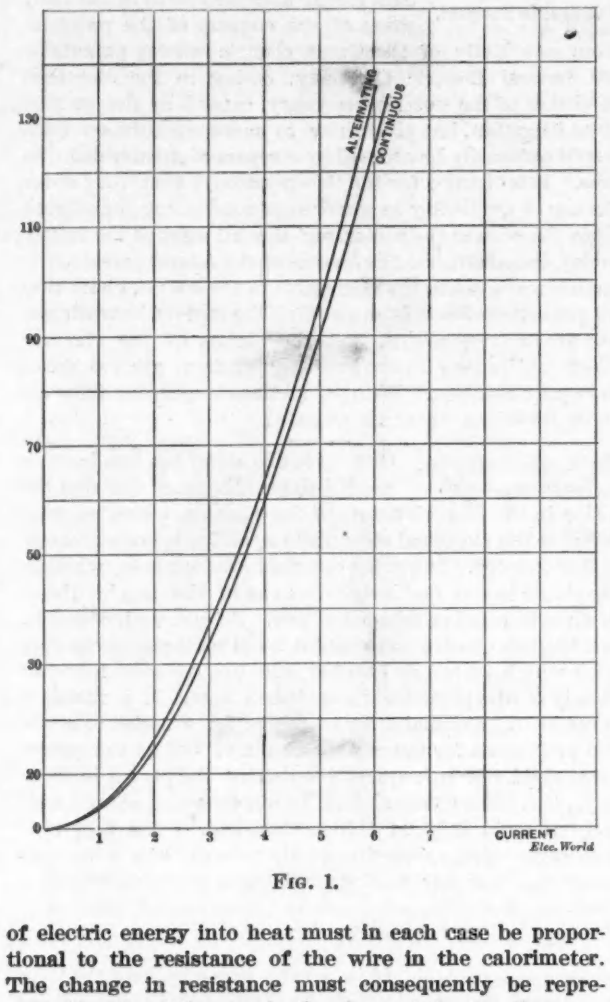


FIG. 1.

of electric energy into heat must in each case be proportional to the resistance of the wire in the calorimeter. The change in resistance must consequently be represented by the difference in the slope of the two lines.

The per cent. increase in resistance of the wire to the alternating current is conveniently shown by the ratio of the difference of two ordinates to the smaller ordinate, which in this case represents the resistance of the wire to the continuous current; the two ordinates taken should, of course, have the same abscissa. For this particular case the increase in resistance amounts to approximately 10 per cent.

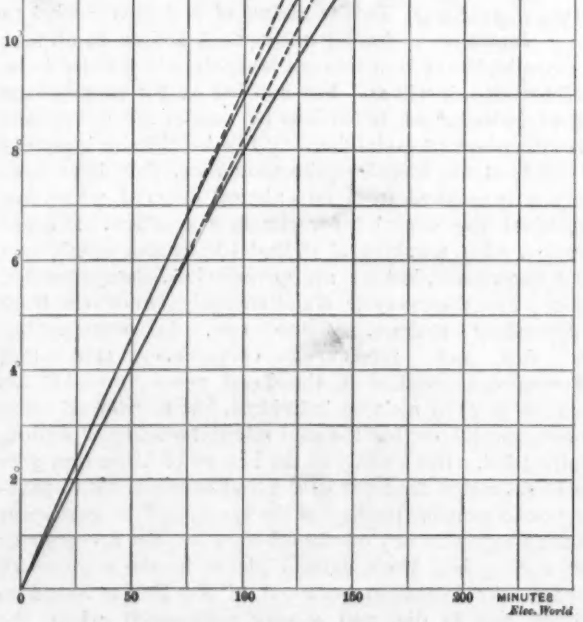


FIG. 2.

These experiments, while only the beginning of an investigation, serve quite well to show the complicated nature of the changes in resistance which a conductor undergoes when traversed by an alternating current, and the matter becomes still more involved when different periodicities are used. Under these circumstances it does not seem advisable, except for the sake of illustration, to define an alternating current according to its heating effects.

Electrical Speed Trials of United States Men-of-War

Under the policy of the government awarding to shipbuilders large bonuses for excess of speed of war ships over contract requirements, the exact measurement of contract trial speed has become a question of great importance to the Navy Department.

Owing to the duration of the trials, from four to six hours, a trial course of sufficient length for the straight run provided in the contract is very difficult to obtain that will satisfy the necessary conditions in regard to straightness and proximity to the shore, and if these difficulties were obviated, uncertainty as to the strength and effect of currents would still remain, even with the expensive use of floats at intervals along the course.

Engineer-in-Chief Melville of the Navy, proposed as a method promising much superior results, that preliminary runs should be made over a measured mile course at different speeds, and the results represented by a curve of speed and revolutions; then the four or six hours' run could be made at sea and the speed corresponding to the average number of revolutions taken from the curve constructed as above.

As the contract bonus in some cases is over $30 a foot, an error of one revolution on the mile run might make a difference of over $500, so it is necessary with this method to very accurately determine the number of revolutions. To enable this to be done an electric speed register was devised at the New York Navy Yard, which was used on the recent trial of the Bancroft with most excellent results.

The instrument is based on the Morse register, but has five pens, one of which is connected with a chronometer and marks seconds on a paper tape, and two others with the port and starboard shafts respectively of the propelling machinery; the remaining two are rigidly connected to each other and mark on each margin when the trial course is entered and left. The pens do not rest on the paper if a contact is prolonged, as in the ordinary Morse register, but fall back far enough to clear the tape after marking. By means of inertia governors the speed at which the tape is paid out can be varied from a half-inch per second to two and one-half inches, and the rate is maintained sufficiently constant by the use of a long spring, of which the elasticity is only used, by means of a Geneva stop, between limits where it is sensibly constant.

On the trial of the Bancroft there were two range observers, one stationed in the bow and the other in the stern of the ship. Before entering on the range the instrument was started (marking revolutions and seconds on the tape) and each observer pressed a key at the instant the range was entered and left. The revolutions and seconds between the range marks on the tape were then counted and the fractions at each end carefully measured, and the results for different speeds plotted, the resulting curve being surprisingly regular.

On the four hours' run the register was used as an ordinary counter, owing to the fact that any loss of revolutions through failure of contact could be detected on the tape and corrected, while this would be impossible with a mechanical counter if revolutions were dropped.

At the launch of the battle ship Texas the same register was used, with great success, to measure the speed of launching, and the coefficient of friction of launching thus was accurately determined for the first time.

Dr. Werner von Siemens.

A commemorative gathering in honor of the late Dr. Werner von Siemens, organized by the Institution of German Engineers in concert with a number of the leading technical societies in this country, was held Jan. 16 at the Philharmonic Hall in Berlin.

The hall was profusely and appropriately decorated throughout; but the centre of interest was the orchestra gallery, where amid the naturally somber, but no less magnificent, surroundings, stood a colossal bust of Siemens, under a canopy of dark velvet bearing in gold the initials of the deceased and the emblems of his work. Six candelabra in the form of columns and draped in black, their capitals surmounted by globes, shed over the whole that subdued radiance peculiar to the electric light; and the snow-white bust catching the rays and heightening the contrast with the dark background completed an effect esthetic and impressive in the extreme. The parapet of the gallery was richly draped in black, and exhibited in large golden Roman letters the years of Siemens' birth and demise, and, below, the closing words of his memoirs, which read in the original German:

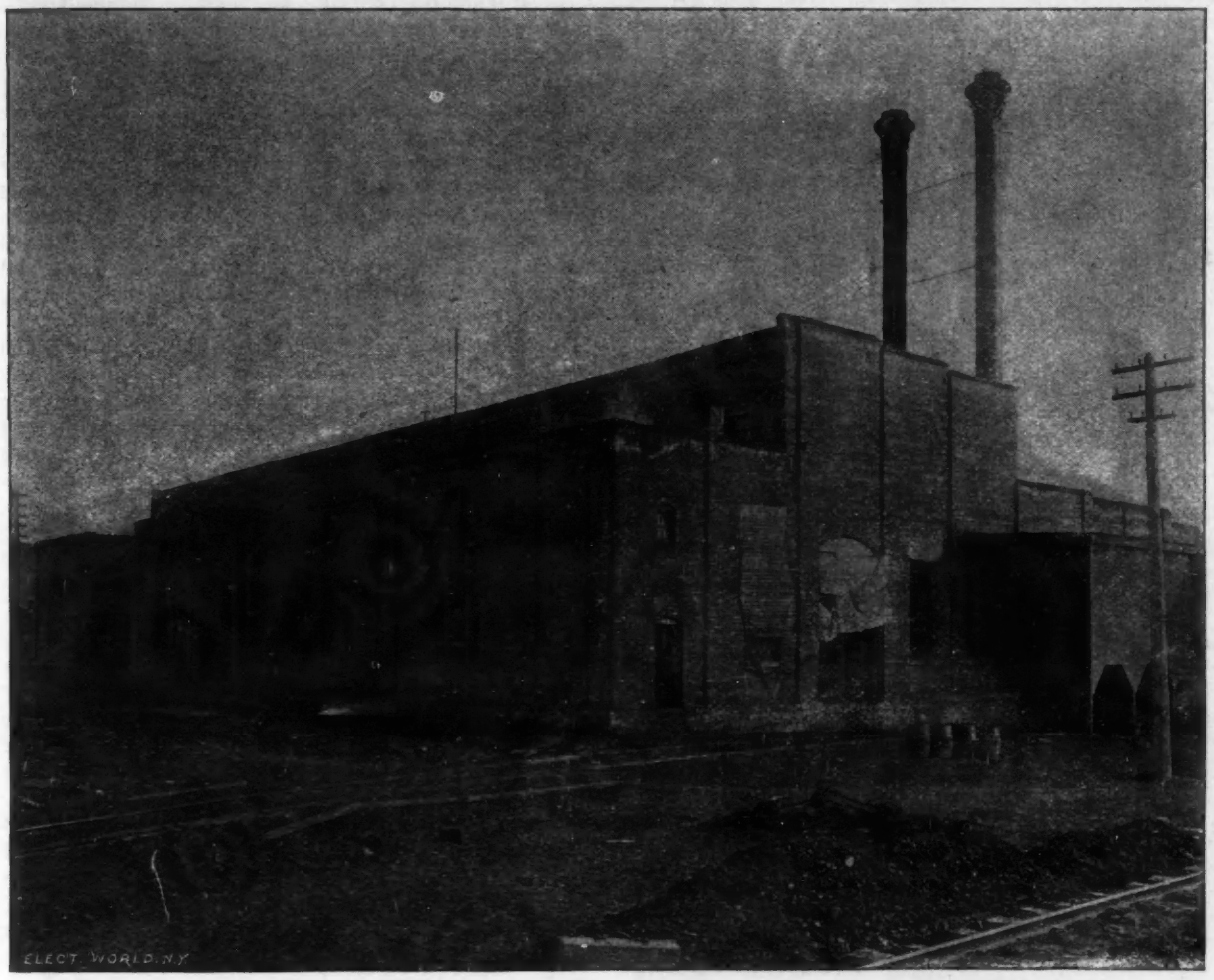
"Mein Leben war schon, weil es wesentlich erfolgreiche. Muhe und nutzliche Arbeit war, und wenn ich schliesslich der Trauer daruber Ausdruck gebe, dass es seinem Ende entgegengeht, so bewegt mich dazu der Schmerz, dass ich von meinen Lieben scheiden muss und dass es mir nicht mehr vergonnt ist, an der vollen Entwicklung des naturwissenschaftlichen Zeitalters weiter zu arbeiten."

At half-past three the Empress, the Empress-Dowager Frederick, Prince Henry and Prince Albrecht entered the royal box

The ceremonies commenced with an organ prelude by Caldera and the singing of Jomelli's requiem: "Requiem aeternam dona iis, Domine!" by the cathedral choir,

The Electrical Side of St. Louis.—I.

"St. Louis (the city selected for the next convention of the National Electric Light Association to be held during Feb. 28 and March 1 and 2) is central to a greater productive area than any other city of the country, and as a distributing centre has no equal, geographically. In every direction she is surrounded by populous, prosperous States; in no quarter is the extension of her commerce hampered by natural barriers of any kind, but to every point of the compass a profitable field for trade is found close at hand. It is her natural advantages of position and her effective development of those advantages that have made her the focal point for the thousands of miles of railroads that are daily bringing to her gates in greater variety than falls to the lot of perhaps any other original market the products of the empire of which she sits as queen and returning in ever increasing quantities the wares of her merchants and manufacturers. The commerce of St. Louis is sustained by no artifical or extraneous conditions, but is in itself the loadstone which with constantly increasing magnetism draws to the common goal from every direction the railroads which seek it." Thus speaks a writer familiar with his subject and having the courage of his convictions. But while St. Louis has attracted to herself diversified products from without, she has been no less enterprising in providing diversities for exchange and for the comfort and convenience of those who live within her gates or are attracted thereto by her marts of trade.



ST. LOUIS & SUBURBAN POWER HOUSE AT DE HODIAMONT.—EXTERIOR.

In no direction has her internal growth been greater than in the manufacture of electrical supplies and in the adaptation of the electric current to the growing demands of the times. Speaking of this, Mr. Geo. H. Morgan, in a review of the years 1891 and 1892, says: "Within the past two years St. Louis has advanced from a comparatively obscure position in that field to a prominent place among the cities of the United States as a user of electricity. As a consequence the manufacture of electrical supplies has become a leading interest here, and in addition to the entrance into that field of several manufacturing houses already established in St. Louis in other lines, there has also been an investment of outside capital in the local manufacture of electrical supplies, which add materially to the growth of this city's manufacturing interests. The business done here during 1891 aggregated at least $5,000,000, and the year was a most profitable one in its showing in the field of electrical supplies. With the inevitable steady development in the use of electricity in all the varied purposes for which it is adapted, the next few years are bound to record still more satisfactory progress in this comparatively new line of business."

It is with the purpose of recording this progress, so especially interesting at this time by reason of the approaching electrical convention, that this series of articles is undertaken.

In describing a city to one unfamiliar with it, the simplest way to convey an idea of it is to compare it to some other city with which the hearer is familiar. With St. Louis this is impossible, as it possesses an individuality of its own, and, as the familiar saying goes, "it must be seen to be appreciated." Built very largely with its own capital, it has lacked the advertisement that foreign capital would have given it. Without the bluster of New York or Chicago, it covers an area comparable with either, and though not attracting the attention in the commercial world that they do, it occupies no mean position among the first cities of the land, and, for financial solidity, is comparable with any. As compared with Chicago, the slur is often cast that it occupies the same position relative to that city that Philadelphia does to New York; but this is at once resented by all true St. Louisans. The charge of conservatism is often made against it, as though conservatism were at a fault. But conservatism, due to conscious worth, is very different from that other kind due to inertia, with which later term it is too often considered synonymous. That St. Louis it not conservative in this latter sense, one need look no further than to its position in the electrical world to be convinced. Within the past three years she has taken a leading place among all her competitors in the application of electricity to useful purposes. Already abreast of Boston and the twin cities of St. Paul and Minneapolis in the extent of her electric railway systems, she has surpassed them and others in supplanting the cable and the locomotive with the electric motor. In electric lighting stations, in respect to size, she stands to-day facile princeps among all the cities in the world, furnishing from a single station 80,000 incandescent lights by the alternating system. In the size of her arc light equipments she also stands supreme, the Municipal Arc Light and Power Station having been for a long time by far the largest in the world. Both of the large plants referred to will be surpassed by the plants at the World's Fair, but they so far exceed other establishments of the kind that it seems unlikely that their nearest competitors will be able to overtake them.

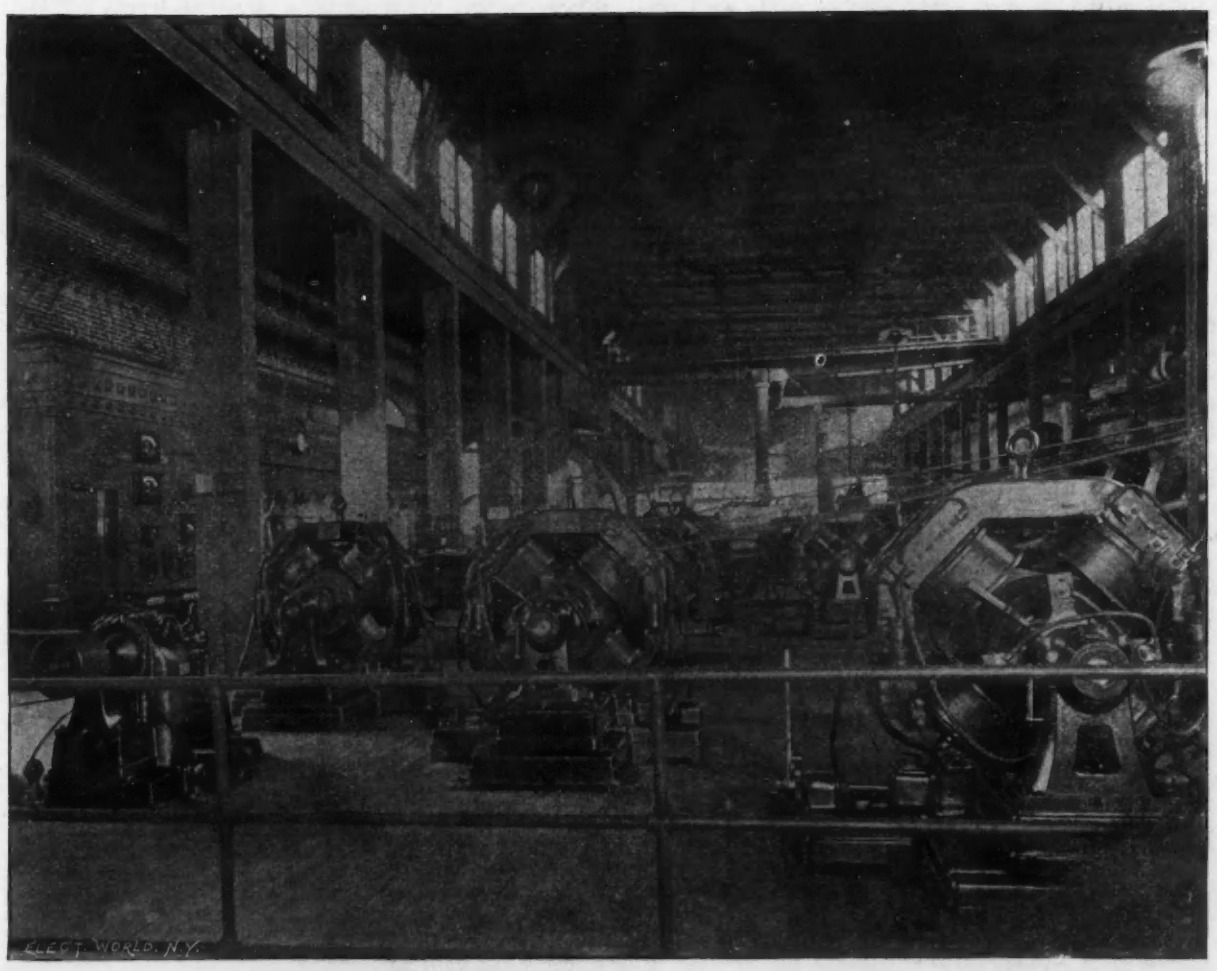
St. Louis also enjoys the distinction of having been a pioneer in some important lines of electrical work. The world is already aware of the claim of one of its citizens to having originated and patented the method now universally adopted of flexibly suspending the electric motors to the car bodies in electric street railway equipments. These claims have already been made before the courts, and if substantiated, will create a stir in electric railway circles, scarcely less in extent than that which has resulted from the present incandescent lamp litigation.

Another citizen claims to have established the first central station for purely power purposes that was ever erected, either in this or any other country, and scarcely more than a year ago the world was startled by the announcement that plans were under consideration for connecting St. Louis and Chicago by an electric road over which passengers would be carried at a speed of 100 miles per hour. This, too, was the offspring of a St. Louis mind, and the plans, which at first, were vague and indefinite, have gradually taken shape, and are now in process of fulfillment—the most recent information at hand being that some twenty odd miles of the roadbed have been completed, and that contracts for the remainder have been let.

It was in St. Louis, too, if we remember rightly, that the system of distributing the electric light to lamps in series, by means of the alternating current, without the intervention of transformers, first took shape, and where it saw its highest development and largest application. In St. Louis, also, was made the most intelligent and extensive attempt to adapt the constant current to street railway purposes. That such experiments as these were possible, is sufficient of itself to refute the charge, if such should be made, that St. Louis is conservative in an invidious sense.

But it is not the purpose of this article, or series of articles, to give a history of the electrical development of St. Louis, but to call attention in a somewhat cursory way to its present condition. The past, of which she has nothing to be ashamed, is beyond recall. The future, which is largely in the hands of the newly-organized electrical club, or, rather, in the hands of its members and of Providence, we think is safe.

Like all other large and growing cities, St. Louis has awakened to the necessity of rapid transit within her borders, and it may be said with truth that few, if any, have solved the question so satisfactorily. The extension of her rapid transit facilities was most marked in 1891, when in October of that year the change from cable and steam to electricity on the St. Louis and Suburban line with a mileage of 24.61 gave it an impetus that it has not ceased to this day to feel. This change had more interest and significance than the mileage would imply, for



ST. LOUIS & SUBURBAN POWER HOUSE AT DE HODIAMONT.—INTERIOR.

it involved the abandonment of both steam and cable on already fully equipped roads and the substitution therefor of the latest claimant for favor, not yet admittedly a rival, electricity.

THE ST. LOUIS & SUBURBAN RAILWAY.

As before indicated, this road is one that has already attracted a good deal of attention, and is of extreme interest, from the fact that from the first it has been fully up with the times and has kept pace with the march of improvement in electrical traction. Its management has not hesitated to replace what seemed to be good by that which seemed to be better. Originally it consisted of two separate roads, one known as the St. Louis Cable & Western, extending from the corner of Sixth and Locust streets to Vandeventer avenue, and the other a steam narrow gauge, running over its own right of way from Grand avenue and Olive street to Florissant, 15 miles in the country. The original cable road formerly consisted of 6¼ miles of single track, was fully equipped in the most approved manner and was driven from its power station at the corner of Channing street and Franklin avenue. This cable station covered an area of 175×134 feet, and consists of a substantial two-story brick structure. The motive power was furnished by two 750-h. p. Hamilton-Corliss engines. The steam road to Florissant, while extending but 15 miles, had 17 miles of single track, was built in 1876, and was equipped with two engines, five coaches, one box car and five flats. Its schedule called for five round trips for the twenty-four hours, but it is related of this road that in winter time a single trip occasionally occupied several days on account of the drifting snows which filled at times some of the cuts. In October of 1891 the motive power of both roads was changed to electricity, the cable power station at Channing street and Franklin avenue had been abandoned, the power plant dismantled and removed to the new electric station situated at De Hodiamont, a suburban station about six miles from the city terminus. The narrow gauge track has been widened from three feet to standard, and the consolidated roads have been ever since operated from this single station by means of the electric current. The new power station at De Hodiamont covers an area of 190×75 feet, and is equipped with three 750-h. p. Hamilton-Corliss engines, and Thomson-Houston multipolar dynamos; of these there are ten of 100 h. p. each, and two of 270 h. p., which are usually separately excited; the boiler capacity at 110 pounds of steam is equivalent to 1,200 h. p., and is made up of Rohen Brothers' boilers, these latter being situated in an annex to the generator building. Adjoining this power station the company also erected extensive car sheds, but these were destroyed by fire early in the summer of last year. The location of this power house makes the distance to which current is carried to its further end 12 miles, which we believe is the greatest distance to which current is carried for street railway purposes ever yet attempted. On the west end of the line, namely, that portion lying between De Hodiamont and Florissant, the current is supplied by six feeders of 00 feeder wire. The steepest grade on the route is found at this end, and consists of a single grade a mile long, which reaches 3½ per cent. This the cars ascend on their return from Florissant.

Notwithstanding the distance to which current is carried and the unfavorable conditions presented by this grade, it has been found that the drop in potential is only about 18 per cent., as a maximum under the most trying conditions.

To enable them to meet this and still have sufficient potential to supply the demands at the other end, the current on these feeders starts out with an electromotive force of 540 volts. This is fed into the trolley wire from one or all of the feeders simultaneously as the exigencies of the grades demand. From De Hodiamont to Locust street, a distance of three miles, twelve feeder wires are employed, the excess being required to meet the greater traffic over this portion of the road. The St. Louis & Suburban route is, as its name would imply, distinctively a suburban road, and has reached to a territory, which, although previously in a measure supplied by steam roads, had not up to the adoption of electricity met the demands of suburban travel. While the city terminus of the road is central to the business portion of the city, that part beyond Grand avenue traversed a country almost wholly undeveloped at the time of the completion of the enterprise. It has, therefore, had to make for itself its own traffic very largely, and to this end, in pursuance of the most liberal policy, it has been called upon to do a class of work seldom required hitherto of electric railways. Soon after the completion of the road the adjacent land, which had previously been farm land and sold by the acre, was subdivided and laid out in suburban town sites and villas. This required extensive grading and fills, and the construction of culverts and new roads. The heavy traffic involved in this was much of it done by the electric road, the old flat and box cars, which previously had been part of the equipment of the narrow gauge steam road, being drafted into service for this purpose.

Thus, while the company was doing a genuine service to its patrons, both actual and prospective, it was building up its own business and deriving a revenue of its own.

As an incentive to travel, the St. Louis & Suburban Railway Company, early in its history, purchased a tract of land of about sixty acres on the line of its road, some miles beyond De Hodiamont, upon which it constructed an artificial lake, and which was laid out as a handsome park for picnics and other diversions during the heated season. To this it gave the name Ramona Park, and it has since become one of the popular resorts accessible to the city.

This lake, winding between wooded hills, has been well stocked with fish, and bears upon its surface numerous pleasure boats, which are rented at reasonable rates to those who desire to use them. On an eminence beyond have been erected a tasteful hotel and restaurant, and dancing platforms are scattered here and there throughout the grounds.

From Vandeventer avenue to Florissant the track runs over its own right of way, permitting greater speed than would otherwise be permissible, and 25 miles an hour is not unusual over this portion of the line.

As if in mockery of its defeated rival, many of the old accessories of a steam road still remain. Thus, at Vandeventer avenue we find the old round house and turntable, now equipped with wires and converted to the uses of the newcomer. At Ramona Park the no longer used water tank still holds its silent vigil, and stands a reminder of days that are gone.

Still nearer the city, at the corner of Channing street and Franklin avenue, is perhaps the most pathetic sight of all, viz.; the old cable power station of the St. Louis Cable & Western, now no more.

The St. Louis & Suburban road pursues the following route: From Sixth and Locust streets to Thirteenth; north on Thirteenth to Lucas avenue; north on Fourteenth to Washington street; west on Washington to Twenty-eighth; west on Franklin avenue to Grand; west on Morgan to the old narrow gauge depot; thence on its own right of way to Wells, at the city limits. Thus far it is double track. From Wells to Florissant the road has but a single track, but this is provided with switches every quarter of a mile for passing cars.

In addition to the main line there is also what is known as the Park extension, extending south on Union avenue to Forest Park—a distance of three-quarters of a mile. This is equipped with double track throughout. Thus it will be seen that between Ramona Park and Forest Park the St. Louis & Suburban road is well provided with attractions along its line to induce the pleasure seeker to patronize the splendid service it places at their disposal. In fact, were both of these attractions wanting, the beauty of the country traversed, the romantic dales and villas dotting the newly opened territory, would

RAMONA PARK.—ST. LOUIS & SUBURBAN RAILWAY.

U. S. MAIL CAR.—ST. LOUIS & SUBURBAN RAILWAY.

in themselves be sufficient to induce an extensive travel among those who seek rest and change from business cares.

The territory through which this road runs lies high and is gently rolling and admirably adapted for suburban residences. The demand for this property, created by the facilities afforded by the rapid transit, has been such as to rapidly increase the prices of lots, and to cause the sale to desirable parties of those most advantageously situated. The real estate man has here been busy, and a trip through the country reminds one somewhat of a graveyard, on account of the numerous signs which everywhere greet the eye. As far as Grand avenue the cars run at three-minute intervals, and beyond, with increasing intervals, to the further points. One of the novel features of the equipment of this road is a U. S. mail car, which daily makes trips over the route and distributes to the villages through which it passes the mail, which it is now proposed to sort in transit, after the manner so long adopted on steam roads. This same car also at times carries small freight or express matter, and we are informed that it is the intention of the management to eventually place upon its line a regular express car for the accommodation of its patrons. When this is accomplished the Suburban road will have entirely usurped the business which heretofore has been strictly confined to lines operated by the steam locomotive.

Mindful of the comfort of all classes of patrons, the officers of the road have provided that each alternate car shall be a smoker; thus those who are addicted to the weed, and those to whom it is objectionable, may each be accommodated with their choice, by a delay not exceeding three minutes. In the summer time the open cars are generously used, but, strange to say, at first met considerable opposition on the part of some of the patrons, who, from time to time, complained to the officers that they were subjected to the winds and the weather on their account, to the detriment of their health and comfort. The reply to such was characteristic of those in charge, for they are reported to have said that they built for the future and not for the present, that they built for young blood and not for the old. Notwithstanding this, some closed cars are in constant use, even during the hottest months, so that even those who object to the exposure complained of may find accommodations to their taste.

The rolling stock consists of thirty-one box motor cars —fourteen of which have 16-foot car bodies—one is 21 feet long and another is 25 feet long. There are also in use during the summer time thirty-one summer motor cars, thirty box trailers and thirty summer open trailers. There have also been recently added twelve 25-foot motor cars, making a total of seventy-four motors and sixty-two trailers.

As the traffic increases the equipment is added to, the tendency being to increase the length of the cars as well as their number. The high speed which the cars are enabled to make on their own right of way—often reaching to 25 miles per hour— has rendered the use of double trucks almost imperative, and it is understood that cars of this construction have been ordered. The writer distinctly remembers a thrilling ride not many months ago over the private way of this road on a four wheeled car at full speed. The roadbed was not then as smooth as it is now, and it seemed as though every moment the car would leave the track, and whether it would thence take wings and fly or remain on the ground were the unsolved questions that most strongly presented themselves.

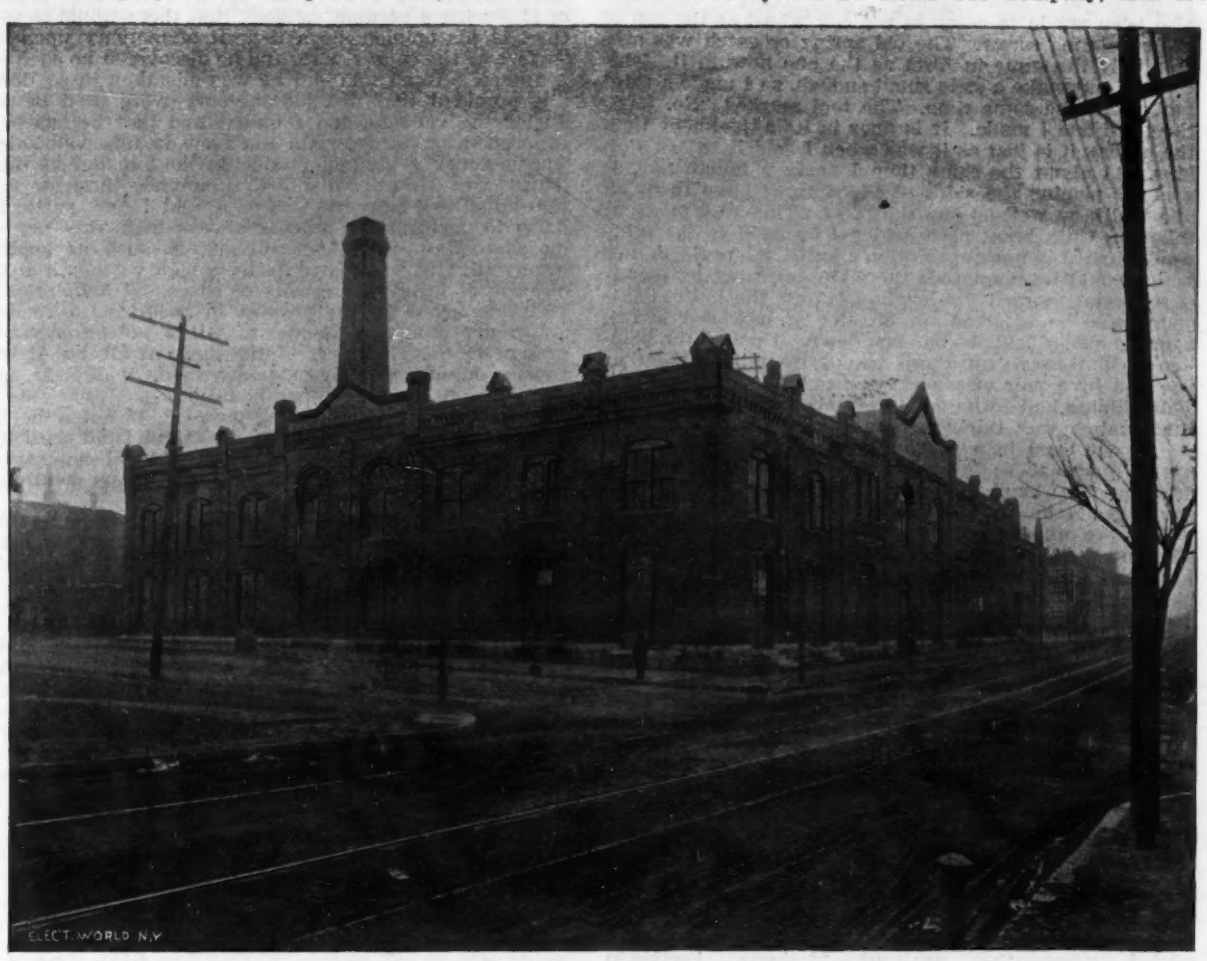
But to return to the equipment. Most of the cars were made by the St. Louis Car Company, and are equipped with two 15-h. p. single reduction Thomson-Houston motors.

As this road describes the nearest practicable route between its two termini, there is no opportunity of tying the feed wires together, and the distance by way of the rails to either terminus is therefore the distance to which the current is carried. Although, as we shall see, another electric railroad in St. Louis has a greater mileage of track, there is none here, and probably none elsewhere, on which current is carried so far as upon the St. Louis & Suburban Railway.

While this road is not the oldest of those that will attract our attention, it has pushed further in the direction of growth of the city than have any of the others, but it is not without rivalry in the territory it enters. In fact it has the keenest of rivals in the Lindell Street Railway, or perhaps it would be more proper to put it that the latter has a rival in the former. The Lindell, being the older, had already reached out to the west and competes by two lines for traffic to Forest Park; but the St. Louis & Suburban, by acquiring the old narrow gauge steam road, stole a march on its competitor and added many miles to the suburban territory tributary to its lines.

Of the increase in value of real estate directly attributable to the adoption of electricity on this road it may be said that the suburban lots which a year ago sold for $10, $15 or $20 per front foot advanced in six months to $20, $25 and $30, and now are worth $10 more, and difficult to obtain at any price. Thus the electrical enthusiast is enabled to claim with pride that what the steam and cable roads failed to accomplish in fifteen years has been wrought by their successor in one.

The officers of this company are: Chas. H. Turner, President; Samuel M. Kennard, Vice-President; S. D. Barlow, Jr., Secretary and Treasurer, and T. F. Sneed, Superintendent.



ABANDONEDCABLE POWER STATION ST. LOUIS & SUBURBAN RAILWAY.

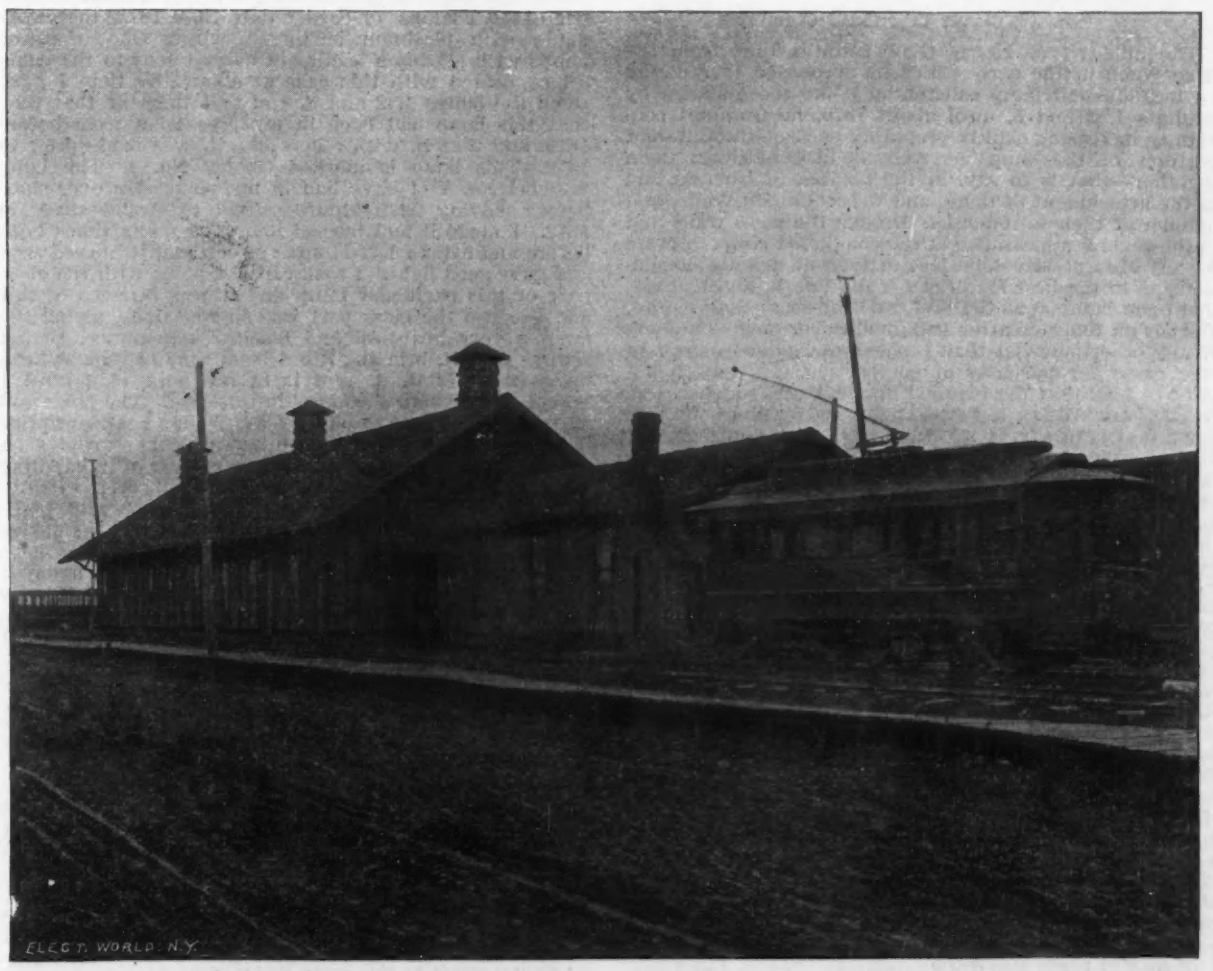
The St. Louis Electric Club.

The St. Louis Electric Club, which was formed in December, 1892, has met with very flattering success for so young an organization. Its connection with the approaching convention of the National Electric Light Association has brought it into considerable prominence, as it has made every effort to provide for the entertainment of the delegates and to look after their interests in various ways. Such an organization is beneficial not only to its members and to the local electrical interests, but its influence is felt to a greater or less extent throughout the electrical field.

The present officers of the club are: President, Robert McCulloch; vice-president, F. E. Nipher; treasurer, J. A. J. Shultz; secretary, C. R Scudder; house committee, Jas. I. Ayer, H. A. Wagner, E. D. Meier and Geo. F. Durant; entertainment committee, J H. Rhotehamel, H. A. Wagner and W H. Bryan; committee on ways and means, J. A. J. Shultz, W. L. B. G. Allen and C. R. Scudder; committee on literature, F. E Nipher, Louis Nahm and E. J. Bagnall.

The following is a list of the members:

G. Pantaleoni, Chas. H. Turner, Walter Krausnick, A. C. Wolfram, Fred E. Allen, Capt. Rob't McCulloch, J. H. Siegrist, Jr.; S. G. Booker, S. B. Pike, H. C. Henley, W. N. Matthews, F. A. Churchill, Jr.; A. W. Meston, E. H. Abadie, F. G. Schlosser, Geo. F. Durant, C. P. Higgins, A. C. Garrison, Geo. F. Steedman, T. C. White, Henry H. Kerr, A. J. O'Reilly, James Campbell, Geo. J. Percival, J. F. Gerleman, F. E. Bausch, E. D. Meier, Geo. Kingsland, T. M. Ambler, J. H. Steedman, Arthur S. Partridge, F. C. Hughes, Louis P. Aloe, Lemon Parker, E. A. Meysenburg, A. C. Thompson, W. L. Flower, Wm. C. Frederick, Paschall Carr, Wm. W. Dean, Samuel G. Stone, A. J. Hatch, Geo. P. Jones, F. Schwerdtmann, Thos. Ashburner, R. H. Bohle, H. L. Parker, Louis Nahm, J.J. A. Shultz B. C. Alvord H. P. Broughton, H. A. Wagner, C. R. Meston, E. V. Matlack, E. Ruebel, W. L. B. G. Allen, James I. Ayer, Chas. E. Sharpe, C. R. Scudder, R. V. Scudder, E. J. Bagnall, James H. Rhotehamel, A. Siegel, Chas. P. Lampel, H. H. Humphrey, A. C. Einstein, J. E. Gatewood, B. H. Lowrey, E. W. Moon, Prof. F. E. Nipher, A. M. Morse, Dr. Wellington Adams, H. Elliott, H. Elliott, Jr.; W. H. Elliot, Wm. Wurdack, J. A. Vail, Geo. D. Rosenthal, W. H. Bryan, Geo. R. Olshausen, Norman T. Holmes, Lainie Higgs, D. W. Guernsey, J. S. Minary, J. M. Davy, Abe Cook, P. M. Kling, Frederick B. Brownell, John B. Hughes, Thomas V. Hall and Fred B. Adam.



STATION AT FLORISSANT.—TERMINUS ST. LOUIS & SUBURBAN RAILWAY.

The Edison Lamp Patent—Additional Affidavits.

On Wednesday, Feb. 1, counsel for the defendants appeared before Judge Colt in Chambers and presented the printed affidavits and arguments, according to the ruling of the Judge made a week before. They also stated that they had 35 to 40 additional affidavits, making 69 in all, covering new testimony, and also several new exhibits, which they desired to present for consideration, and to have brought into the case. Mr. Fish, of counsel for the prosecution, not being present was sent for, and argued against the admission of the new testimony and exhibits. The arguments pro and con. lasted for an hour and a half or two hours, when Judge Colt decided that he would accept and consider as part of the case any new testimony or exhibits submitted by either side. It having been noted by the defendants that at the previous hearing the prosecution criticised more severely what they did not show than anything that they did show, the new affidavits in the argument were intended more particularly to cover this ground. Affidavits were presented on the part of the defendants by the following parties: Charlotte Finck, Thomas Conroy, Henry Crawley, Chas. Forschner, F. L. Pope, Jas. A. Vandergrift, David A. Hall, Henry Goebel, Jr., Johanna Pashbach, August F. Hager, Peter Schellens, Edward E. Mulligan, Edward J. Kering, Peter H. Fox, Anna Mary Huebsch, Louisa S. Stark, George Pashbach, Alfred F. Cross, Wm. H. Williams, Chas. G. Perkins, Alan D. Kenyon, Benj. F. Chambers, H. S. Copeland, Henry Ginnel, William Newman, Edward J. Hagen, Dellef C. Voss, R. H. W. Baker, H. Kusterer, Henry Goebel, Chas. R. Cross, and Edward E. Cary.

Among the new exhibits was another lamp similar in length and diameter to those already submitted, but having platinum leading-in wires and the hairpin form of filament. This globe is composed of two parts, the lower —in which the platinum wires are sealed—being of lesser diameter, the two parts being fused together making a continuous tube.

The leading-in wires, as before stated, are platinum until they have passed through the glass, from this point to the point of attachment of the filament the wires are copper. Both ends of the filament are attached to these copper wires as before described in the other exhibits, by a flattening of the terminals, a twisting and a cement of stove polish. The terminal seal of this lamp is pointed as in the lamps of the present day, but the extreme end of this point has been cracked off, as if by a fall, but has not destroyed the vacuum. The lamp to all outward appearances is a perfect one, but it is found that the circuit is broken at some point, supposed to be at one of the junctions between the platinum and copper wires. The vacuum has been tested and according to the testimony of Mr. F. L. Pope is sufficient to enable the lamp to burn for about 400 hours.

THE AFFIDAVIT OF HENRY GOEBEL.

The affidavit of Henry Goebel states that from the time when in the early fifties he succeeded in securing an incandescent lamp substantially like those shown by exhibits 1, 2 and 3, until about 1879, he acquired constantly increasing skill in preparing each of the different features of the lamps as well as in connecting them together—that is to say, in the making of carbons and in the attachment of them, and the leading-in wires, and manner of their introduction through the glass walls and in the general appearance of the completed lamp. Before he left Monroe street he had arrived at definite conclusions as to the best material for the lamps, and had settled upon bamboo as the best, and for some time before, and for all the time after 1872, had never made filaments of any other material than carbonized bamboo except in rare cases for purposes of comparison. He had found prior to 1872 that the bamboo filament was tougher, less fragile, would give a better light and a more durable light, that is to say, in all these respects taken together, he had settled upon the bamboo filament as superior. He had prior to 1872 a set of mechanical devices four in number, for the purpose of producing a very fine and uniform thread or hair of bamboo for use in these lamps. On Jan. 26, 1893, one of these devices was found in one of his tool boxes and was given to Messrs. Witter & Kenyon. It is marked "Goebel No. 6." This or other similar mechanical devices were used for the purpose of producing a hairlike piece of bamboo, from before 1872 for a good many years. On or about 1886 he sold to Mr. Perkins three of his tools for making carbon for incandescent lamps. Two of these tools were handed to him on Jan. 31, 1893, by Mr. Perkins, and he recognized them as the tools he sold Mr. Perkins, as above stated. He marked them respectively "Goebel No. 7" and "Goebel No. 8." The tool marked "Goebel No. 6" was the first tool used for making the strips for Goebel's burners. He says, "I made it in the early sixties when I was living at 271½ Monroe street; it consists of a plate which I screwed to my work table; in this I had inserted a knife, the projection of which I could regulate by a screw. I hinged another plate to the same which bore a roller engaged and pressing on the bamboo and facilitating the passage of the same between the former and the knife. This hinged plate was drawn down by foot or hand and returned to its elevated position after the pulling through of one piece of bamboo for the next operation. I had a screw on the same by which its descent could be regulated. This tool I made for the express purpose of producing the bamboo strips for the terminals of my lamps. It was used pretty constantly by me from that time down to the time I stopped making lamps a few years ago. It has never been used for any other purpose; it cannot be. When I made carbons for the American Electric Company in 1881 I made use of this tool. The tool was constructed by me so as to enable me to make the strips smaller and more even than it was possible to make them by hand. The tool marked "Goebel No. 7" was made by me after the tool I have just described; just how long after I do not now remember, but I know it was made prior to 1870, and I think as early as 1865, or earlier. The first tool did not plane the strip as small and as even as I wanted, so I made this second tool to cut the strips smaller and more accurately. This tool has been changed in three respects since I sold it; it had a different knife in it, although it was one substantially the same in shape; it had a flat spring under the hinged plate instead of round springs; a new spring or catch has also been put in to catch in the cog wheel at the top of the regulating screw. The old spring or catch was substantially the same in form as the one now in it. This tool did not make a strip small enough, so I made a third tool about the same time. The tool marked "No. 8" is the third one I made. It is finer in its adjustment than the others; it is just as it was when I sold it to Mr. Perkins. At about the same time I made a fourth tool; it was for planing the sides of the fibre to have them all one width as well as one thickness. This was made as follows: On a brass plate which I screwed to the table was adjusted in upright position a knife, the projection of which could be regulated; the slide, operated by means of a handle, pressed the bamboo against the knife. This slide could be adjusted for broader or narrower strips; a spring clamp held the bamboo down. I pulled the bamboo strip through all these planes by taking them at one end by a pair of pincers and pulling them through. This planing had to be done very accurately since when the bamboo was thicker at one end than the other it would not bend in a regular curve. I would generally use all four of these devices in making my bamboo strips, drawing the bamboo through the first, second, and so on, gradually and accurately reducing its size. These tools were all used constantly by me in making my filaments. About 1886 Mr. Perkins asked me whether I would let him have some of my tools, and then I gave him the tools Nos. 7 and 8, and the fourth tool which I understand is still in his possession. Before I left Monroe street, 1872, I had for a long time had gas in my house and had made for myself glass-blowing apparatus much superior to that which I had used in producing the glass part of Goebel lamps 1, 2 and 3. Moreover, I had been practicing the art of glass-blowing and other glass work, not merely in connection with these lamps, but in other matters, including hundreds of barometers and thermometers, Geissler tubes, etc., to such an extent that I had acquired quite a high degree of skill in the use of the blowpipe. In making the connection between the leading-in wires and the carbon, I very early arrived at the conclusion that, all things considered, stove polish was the best material for effecting the junction, and before 1872 that was the material which I usually used for that purpose. Prior to that date, also, I had settled upon the use of platinum leading-in wires for the reason that when I used iron or copper the glass part of the lamps would sometimes crack and thus impair the vacuum. I should have used platinum for this purpose in every one of my lamps except that it was more expensive and not so easily accessible as iron or copper wire.

The greater portion of the lamps made with platinum leading-in wires made as good incandescent lamps as were made with those using iron or copper. After I had settled by the use of the lamp upon the superiority of the platinum leading-in wires, almost all of the lamps that I made long prior to 1872 onward, and at both my places in Grand street, were made with platinum leading-in wires, and I had as late as 1890 in my possession a number of such lamps, of earlier date than 1872, that were made with platinum leading-in wires. One of these lamps with platinum leading-in wires I sent to the counsel connected with this case at about the time I gave them the lamps 1, 2 and 3, and told them at that time that this lamp had been in my possession from before 1872, and that it, with others like it, was made prior to 1872. This lamp is marked Goebel No. 4. The lamp "Goebel No. 4" I have had in my possession ever since before moving from Monroe street to Grand street in 1872. I made it and burned it a good many times both before and after I left Monroe street, and it burned well and gave good light. I took especial pains with the glass part of this particular lamp and it was because of this and because the glass part was so well done, giving the lamp a very beautiful and finished appearance, that I always kept it, bringing it out from time to time to light up as an exhibit. I kept it in my possession until I sent it to defendants' counsel in this case. The lamp and all the parts are the same they were when I made it prior to 1872, in material and all other respects, except such changes as may have occurred from my use of it, handling and mere lapse of time. When I made it, prior to 1872. I made it with a bamboo carbonized burner with platinum leading-in wires, copper connecting wires; the modes of connection and the glass tube were just as they here appear except as above stated. If it does not burn to-day it is because it has been in some way injured by handling or lapse of time. When in about the year 1881 people came to me from the American Electric Light Company, I instructed one of their glass blowers to introduce the platinum wire from opposite sides of the glass globes (they were leading in their wires from the bottom); he said they could not do that, or it could not be done, or something to that effect; and then to convince him that it could, I explained that I did it and showed him this identical lamp (Goebel No. 4) as proof that it could be done. Thenceforward, at least for a time, the American Electric Light Company adopted that plan and I produce a lamp marked "N. Goebel No. 5," which is an old American Electric Light Company's lamp with leading-in wires sealed in by that method. When I gave up business in 1890 I took this lamp (Goebel No. 4) with me to my present home and have had it ever since until I surrendered it to the counsel in this case. At the outset of my work in the early fifties I could not blow the glass tubes very well, but I gradually acquired more and more skill both by practice and by the use of gas and much better apparatus. I doubt if I ever made either at Monroe or Grand street any other lamp which in the glass feature was as handsome as this one. I did, however, both in Monroe and at 500½ Grand street, and at 468 Grand street, make and use a good many lamps with carbonized bamboo burners, platinum leading-in wires, copper connections and glass tubes, like the Goebel No. 4 exhibit, in the degree of manual finish of the parts, especially the glass tube, in the respect of not affecting their operativeness or light-giving capacity.

Incandescent electric lamps are fragile things easily broken by handling, falls, etc. This is proved by the best commercial lamps of to-day, and even bamboo filaments will break with rough handling, and the more the carbons are used and burned the more fragile and liable to break by handling they become. The Goebel lamp No. 4 has evidently fallen on its end at some time, because the glass tip is broken off. I have recently been informed that an expert for the defendants, Mr. Pope, had given a reason or reasons why he did not think this lamp, Goebel No. 4, was made by the Torricellian process of producing a vacuum, namely, that there would in such case, in his opinion, be a deposit of mercury upon the surface of the copper wire, and he discovered no such appearance. But I told him he was mistaken in so thinking, provided that distilled mercury were used in producing the vacuum, and I understand that he has been experimenting to ascertain the facts in this connection. The mercury I used in producing the vacuum in these lamps was carefully distilled, sometimes three or four times distilled, before it was used, and I took particular pains to perform the process always in a very dry atmosphere and used other safeguards, such as heating it very slightly, tending to insure a high vacuum and the absence of injurious deposits or gases. I had, prior to 1872, employed for the purpose of producing a vacuum a mercury pump, in the use of which no mercury was present in the glass part of the lamp at all, but it was a pump having stop cocks, which made it difficult, and not always sure of manipulation, so that as a rule I succeeded in obtaining as good, if not a better, vacuum by the Torricellian process than I did with this early mercury pump. This pump, which I now speak of, must not be confounded with the pumps mentioned in my former affidavit.

These lamps, with the platinum leading-in wires, and some of the lamps with the leading-in wires of other material, when connected with my batteries, gave a uniform, steady and continuous light, equal approximately, I should say, to an ordinary gas jet. They were used for a number of just such uses as incandescent lamps are used to-day, and were so used prior to 1879, and from time to time from the early fifties onward. I know no reason why these lamps were not suited for commercial use. These lamps were ready for commerce and commercial use, but commerce was not ready for these lamps, and the reason was that there was no available source of cheap electricity, and the introduction of these lamps to a widespread commercial use involved—even with an adequate source of electricity—the expenditure of vast sums of money. As compared with the incandescent lamps of to-day, these early lamps of mine gave a fairly good light, and an entirely practical light; they burned fairly well, and with the addition of such improvements as have been added to the modern lamp, some of which I am familiar with, they would give, in my opinion, just as good a light and just as reliable a light, as the Edison lamp of to-day. Each one of my lamps that turned out to be successful burned with a candle power equal to that of an ordinary gas jet and maintained that power with some exceptions of accident, until the battery power gave out, or until it had attained a length of life very comparable with that of an incandescent lamp of 1880. By the expression "that turned out to be successful," I mean that sometimes the carbon was not perfect, sometimes the glass was not perfect, sometimes the junction of the various parts was not perfect; in those cases the lamp was not what I considered a successful lamp; but that has always been true in the manufacture of incandescent lamps, and is true even to-day, notwithstanding the improvements that have been added to the lamps and the process for making the lamps.

Exhibit Goebel No. 5 is the lamp which was made during the time I was employed by the American Electric Light Company, principally in making carbons for them at my house, in—as I remember—the year 1881. I made a great many carbons for this company at my house, and I made quite a number of lamps for them like the No. 5; by this they became aware that I could make better carbons and better lamps than they were making themselves at that time. It was for this reason, I suppose, that I made carbons for them. The Goebel lamps Nos. 1, 2, 3, 4 and 5 show for themselves partially the advance in nicety of workmanship, which I acquired from time to time in the manufacture of the lamps, though not as freely as such advances would be shown, provided I was able to produce a larger number of lamps identified as belonging to later and later periods of time. I never put any devices on my electric lamps to conduct heat away; I never used any thermal regulators on my lamps; there was no need for such appliances. The wires that ran into my incandescent lamps would not get warm, nor would the base of the lamps become heated. The wires that I used running from the battery to the lamps were of the ordinary wires used in batteries of the size and kind I employed. They were not very thick, but were like ordinary copper wires. In using my lamps with electric batteries I usually connected only one lamp with a sufficient set of battery cells.

Sometimes, however, I connected two or even three lamps to the same set of battery cells. In this case I could use more cells. One of the very earliest of my efforts to make an incandescent lamp was by using a platinum wire or hair as the illuminating part. It was two or three inches long and was very fine—about as fine as No. 80 or 100 cotton thread. I used a vacuum with this platinum lamp and used copper leading-in wires sealed in the glass; the fine platinum wire heated up and became incandescent and gave a good light, but in a few minutes got too hot and melted and fell on the glass, and the glass broke. I did not try platinum again, but turned to vegetable carbons. I knew from the arc light that I made first, that carbon would not melt, and I thought that in a vacuum where there was no oxygen it would not be consumed and would last, and I discovered that it did last. After I began to work for the American Electric Light Company I employed a glass-blower to do the glass blowing work for me. I always kept a glass-blower at work after that, as long as I made and sold lamps and carbons to other people, which was about a year after I finished working for the American company. During all this time I did not blow glass myself. I was therefore more in practice in glass-blowing when I first came to No. 488 Grand street than I have been since beginning work for the American company, because I have not had as much of it to do since I began working for them. I am an expert glass-blower, or have been in my prime. There was more interest shown on the

part of my neighbors and those who came into my store in incandescent electric lamps that I made on Monroe street, than in those I made on Grand street. This was partly because by the time I moved into Grand street almost everybody I knew had already seen my lamps. Moreover, I was much more closely engaged in my optician and watchmaking business after I moved to Grand street than I was before. Business was better, I had more to do in that line, and had, therefore, less time to make lamps or to show and explain them to others. Again, electricity was more of a novelty when I lived on Monroe street than it was later on. For instance, during the greater part of the time I lived on Monroe street there were no telegraph posts or wires up, at least in our street and neighborhood, but by the time we moved to Grand street or soon afterward, they became very common. I have not received any money or anything of value given for the evidence I have given in this suit, or for anything I have done for the defendant herein, and I have not received any promise from any one of money or anything of value, and I do not desire or expect to receive any. I have given my evidence in this reluctantly and only after considerable urging. I have no interest in the result of this suit. I bear Mr. Edison no enmity, and I do not desire to injure him in any way. I do not own any stock in the defendant corporation, or in any electric lighting company and have no interest of any kind in that business, and not only have no interest of any kind whatever in the defendant company, but I do not even know any of its officers or any one connected with it.

I remember a glass fountain which I made while I lived at 500½ Grand street. It was so arranged that drops of water and bubbles of air passed through it; first would come a drop of water, then a bubble of air, then a drop of water and so on. I kept this for a long time in the window of my store, 500½ Grand street, and at 462 Grand street. I made the fountain myself. There was a great deal of very nice fine glasswork about it, and I remember that I had to be very careful about this glass blowing work. There were a great many glass tubes about it, and these glass tubes had to be very small to keep the drops of water from coalescing. Many people, among them a number of glass-blowers, I remember, came into my store to examine and inquire about this fountain.

AFFIDAVIT OF FRANKLIN L. POPE

Franklin L. Pope gave the following testimony:

I have heretofore made an affidavit in this case. At the time of making my former affidavit, I felt doubtful whether the date of the lamp marked Goebel No. 4 could have been as early as Mr. Goebel and his son Henry have always asserted it to be. They have both asserted from the beginning of my acquaintance with them, about two weeks ago, that this lamp was made before their removal from Monroe street, in 1872. My doubts in the matter have arisen from the circumstance that the joint between the carbon and the copper wire appears to have been made in part of electroplating, and my own experience in such matters led me to entertain the opinion that if the lamp had been first filled with mercury and then exhausted by inverting the tube in one of the ways which Mr. Goebel says he practiced, the mercury would have united with the surface of deposited copper and some traces of it would probably have remained; and as no such trace of it appears to be visible in this lamp, I was led to believe that it must have been exhausted upon a vacuum pump, and not in the manner before referred to. I was instructed by defendant's counsel to investigate the matter from a scientific point of view most exhaustively, and to make any necessary experiments for that purpose, which I have done.

Upon first questioning Mr. Henry Goebe on this matter he at once told me that he used heated chemically pure mercury for his work, and that he took care that the exhaustion was performed in dry weather and not in moist weather. He also stated that when chemically pure mercury was used, it woud not unite with the copper. In order to test the truth of this statement I at once procured some chemically pure mercury from Hegeman & Co., and electroplated two pieces of copper wire in satisurated solution of sulphate of copper, diluted in sulphuric acid. This was on Jan. 26, 1893. After a sufficient coating of fresh metallic copper had been deposited upon the wires, I immersed one of them in the chemically pure mercury, and the other for half an inch in depth in some ordinary commercial mercury, which I had on hand. The result was that the chemically pure mercury did not adhere to the copper or leave any discoverable trace of itself on the copper, thus absolutely confirming what Mr. Goebel had said; whereas the impure mercury formed an amalgam with the copper on the surface, leaving an evident and discoverable trace of its presence. I submit herewith two samples of wire with which the test was made, marked with my name and date of this affidavit, This conclusively disproved and explained the only doubt that had arisen in my mind from my most careful and scientific and practical examination of the lamp, and conclusively demonstrated that the lamp, Goebel No. 4, might have been exhausted by the Torricellian process of filling the same with mercury and then inverting and emptying it, without necessarily leaving any traces of mercury on the copper interior parts. The result of this experiment removed the only reason for doubt which had previously existed in my mind as to the probable date of this exhibit. Of course, if the lamp No. 4 had been exhausted by means of a mercury pump in involving the presence of mercury in contact with the interior parts of the lamp, my objection would have had no force. There is nothing inherently improbable in the doing of glasswork of the kind and character exhibited in the lamp Goebel No. 4 in 1872 and for several years before that date. I remember that at least as early as 1868 Geissler vacuum tubes were made and sold in considerable numbers in Boston by Ritchie, and that they had been imported from Europe and publicly exhibited in this country several years earlier than 1868. Some of these Geissler tubes had platinum wires sealed into the side of the exhausted glass tube in the same manner as wires are sealed in the Goebel lamp No. 4.

I have tested this lamp as to its resistance. I can get no current from it, which shows that the circuit is somewhat broken. I have carefully examined the carbon filament with the microscope, and also the joint which connects the carbon filament with the separating copper wires, and can discover no visible sign or indication of a break. I am of the opinion that the break is not in the carbon, but is somewhere along the line of one or other of the two interior copper conductors, or of the double platinum leading-in conductors, or in one or other of the joints between the copper and the platinum. I estimate that the luminosity of the lamp Goebel No. 4 (if this break do not exist) would be approximately 10 c. p. with the proper current. Such a current was readily obtainable in 1872, and long before that time, and by means of the appliances and in the way described by Mr. Goebel as possessed and used by him in 1872 and before. Goebel lamp No. 4 (with the hidden break repaired) would be entirely capable of practical use, exactly as incandescent lamps are used to-day, and the same thing is, of course, true of the lamps said by Mr. Goebel to have been made and used by him in 1872, and before and after, exactly like the exhibit No. 4. Barring accidents (which occur now and then with all styles and grades of work in this art, because the structures are so delicate and fragile), I am of the opinion that the length of life of lamps made exactly like the Goebel No. 4 in all details of construction and workmanship, and made exactly in the way and with the tools and appliances referred to by Mr. Goebel, as used by him in his Monroe street house in making these lamps prior to 1872, were on an average of not less than 150 to 200 hours, and perhaps more, and I mean by that with the ordinary rough usage that lamps meet with in commerce and burning with the brilliancy and power of the modern incandescent lamp of 10 c. p. An incandescent lamp of that candle power is entirely commercial, and they are sold both in this country and in Europe.

Recurring to this lamp Goebel No. 4, and after the most careful investigation of every part and detail within and without—carbon, joints of carbon to copper, copper to platinum, platinum leading-in wires and their sealing and glasswork generally—I am clearly of the opinion that there is no reason discoverable in the lamp itself or in the account of how it was made why that particular lamp, and lamps in all respects like that lamp, might not have been made by Mr. Goebel as early as before 1872, and long prior to 1879.

Lamp No. 4 represents an advance in the care and skill of making and putting together the various parts of the lamp, and especially in respect to the workmanship and finish of the inclosing chamber, just as I would naturally expect a man of Mr. Goebel's ingenuity and delicacy of manipulation would make.

I am familiar with the construction and appearance of the Goebel lamp No. 4. It has an arch-shaped or hairpin filament, and rectangular cross section made of a thin strip of carbonized endogenous wood. This cross section, as near as I can judge, is about .0066 × .012 inch. The luminous part is about 2.5 inches long and the leading-in wires are platinum. Between the platinum and the carbon a piece of copper wire is interposed and the joint between the carbon and the copper appears to have been electroplated with copper, as there is a superficial deposit of copper upon the wires. I can see no trace of mercury within the lamp. The circuit through the lamp is now broken, but the oxidized appearance of the filament indicates that it has been kept for some time at incandescence. I can observe no indication of hydrocarbon treatment upon the filament. I have had the lamp tested by an induction coil, and find it still maintains a vacuum. The workmanship of the work shows a considerable degree of skill, especially the mounting of the carbon. The seal is more than a quarter of an inch in length, and similar to that used in the early forms of vacuum tubes, such, for instance, as those shown in the fifth edition of Du Moncel's work on the "Ruhmkorff Induction Coil," published in Paris in 1867, particularly in Figs. 44 and 45, on page 123; in Figs. 71 and 72, on page 210, and Figs. 74, 75 and 76, on pages 218 and 222, with a fairly good vacuum. I have no doubt that this lamp might burn several hundred hours, three or four hundred at least.

The Goebel lamp No. 5, made for the American Eelectric Light Company, in 1881, as I understand, I have most carefully examined. This lamp is substantially the same as those now in general use. It has a pear-shaped globe two and three-quarters inches in diameter at its largest part, and six inches long. The filament is of carbonized endogenous wood, rectangular cross section, and is very similar to that of lamp No. 4, except that it is thicker. I estimate the filament to be about .012 by .025 and its light-giving portion four and a half inches long. It is secured to copper wires which are twisted in coils at the end in which the ends of the filament are thrust, and the joints are covered with a cement which looks like an alloy of mercury and gold. The leading-in wires are of platinum and round and are sealed into the sides of the glass chamber in the same way as in the Goebel lamp No. 4. The glass work of this lamp is of the same style as No. 3, but the finish is better. The resistance of this filament cold is 133 ohms, and would be about 66 when heated. It does not appear to have been treated by the hydro-carbon process, but looks as though it had been burned. It is a good commercial lamp, I think as good as any that were made in 1881, and could have been made at that time as Goebel states in his affidavit.

Comparing the construction and workmanship of Goebel lamps No. 1, No. 2 and No. 3 with Goebel lamp No. 4 and that with Goebel lamp No. 5, I think a steady progress is shown in matters of detail of construction and workmanship. This is particularly the case with the glass work which in the early lamps is crude and unskillful. The carrying of the wires through the end of the lamp with a thick mass of glass formed around increases the liability of leakage and fracture. No. 4 is in fact quite as good in every respect as the commercial lamps in use in 1881 and 1882. The filament is uniform in thickness, having appearently been shaped by machine; copper wires with a cross bridge of glass are placed between the filament and the platinum wires as in modern lamps; the seal is elongated and thus made secure, and the leading-in wires are made of platinum carried through the side walls of the chambers, thus largely reducing the liability of leakage and fracture. These improvements are just such as would naturally result from increased experience and skill gained with the practice of the art.

In my opinion the Goebel lamp No. 4 and the lamps made like it in 1872 and before and after, embodies the invention of the second claim of the Edison patent in suit, as the same has been construed in the prior adjudications, having all the elements of the claim combined and operating as there set forth.

Referring to the question of iron leading-in wires, it is a fact that iron, of all the metals, is the one which stands nearest to platinum in the approximation of its coefficiency of expansion and contraction to that of glass, so that its use for that purpose is next best to the use of platinum. It is also a fact that glass of any quality differs from another in its liability to fracture. It is again a fact that the finer the wire in either case the less the danger. In my opinion wire platinum is superior for the purpose, and so superior that in manufacturing on a commercial scale where the percentage or average is required to be very low, platinum has heretofore had to be used, still I believe it to be possible to make perfectly operative lamps capable of practical use with iron leading-in wires. It would require more care in sealing than it would where platinum is used and there would be more lamps fail in every dozen made. But the lamps that do not fail at once ought, some of them, to burn as long and as well as would be required in a commercial lamp for some purposes. To the best of my knowledge and belief the art of sealing platinum wires into the walls of the glass chamber for the purpose of conveying electricity through the side walls was known as early as 1860.

I have tested the Goebel lamp No. 4 for vacuum by charging with nigh tension electricity and induction coil in a dark room. It has a fairly good vacuum, enough in my judgment to keep it running two or three hundred hours. The color of the luminosity indicates that there is no oxygen in the lamp and hence that no leakage of air into the lamp has occurred since it was made.

AFFIDAVIT OF JAMES A. VANDERGRIFT.

James A. Vandergrift deposes as follows: I have been handed by W. H. Kenyon, Esq., an incandescent lamp marked "Goebel No. 4," and requested to make certain tests and report upon the results of them. I have made the tests desired, and have arrived at the following results and conclusions: There is a fair vacuum in this lamp—sufficient to enable the carbon to last between 100 and 200 hours when burning at normal temperature; an average life of between 100 and 200 hours was a good length of life for a commercial lamp in the year 1880. I find that the filament has been made from a piece of course bamboo; its structure, when compared with a piece of fine bamboo, differing from it only in degree, but not in nature. The filament has been carbonized—it shows evidences of having been burned for some time, and seems to be slightly oxidized upon its surface—but it is not, so far as I can see, materially injured. The indication of the oxidation of the carbon surface of the filament is not peculiar for this lamp or unusual. I have noticed it in respect to modern commercial lamps containing untreated filaments. This effect is shown by long and continuous use with a good vacuum, or by a shorter use with a lower vacuum. There is a broken circuit through this lamp, but I have not been able to discover that the break occurs in the carbon. This would seem to locate the break at the junction of the wires. The leading-in wires are of platinum; the supporting wires connecting them and the filament are of copper. I see no reason why this lamp could not have been made as early as 1872, or earlier. The glass work, in some respects, seems to be an adaptation of the mode of sealing which I understand to have been practiced earlier than that date; for example, in the Geissler tubes. The platinum and copper wires are fully large enough to carry the current when the lamp filament is heated to incandescence, judging from the size of the latter. I find no indication from an examination of this lamp that hydrocarbon treatment has been applied to the filament, and my best judgment is that it has not. In respect to the quality and appearance of the carbon and the quality of the glasswork and the workmanship of the lamp generally, this lamp, in my opinion, would have as good a commercial life as the lamp described in the Edison patent here sued upon; the only question determining the hours of its life being the vacuum.

William H. Williams, counsellor at law, 188 East Twenty-third street, New York City, makes affidavit that he has recently made careful and prolonged investigations to determine when gas was introduced into Monroe street, this city, and has concluded from all that is accessible from gas companies' records and other information that gas was introduced into Monroe street in or about the year 1854.

Peter H. Fox states that in or about 1880 the American Electric Light Company was organized, and that he was employed by them from their organization, first in Centre street, and then in Church street, for a period of one or two years. Very soon after he became acquainted with Henry Goebel. The American company had trouble with their carbons at first, and he remembered that that was one reason why they employed Goebel. Had seen Goebel making carbons at his house, and these carbons made by Goebel were very good. Further testified that Goebel made a great many of these for the American company, that they were used in many of the lamps made and sold by the American company and used by its customers. Mr. Goebel worked for the American company about a year, as he remembered it, somewhere about the end of 1880, or the beginning of 1881 to the year 1882. About the time he began work for the company he (Fox) called at Goebel's store on Grand street and became acquainted with him. Goebel then showed him (Fox) a number of old lamps he had made, and told him he had made these lamps and others like them for many years, and explained their history to him. Some of these were just like the lamp in the photograph shown Mr. Fox. When he first became acquainted with Goebel he was a very skillful glassblower; he was also very skillful in making the carbons and attaching them to the wires and attaching them to the lamps. The American company tried to make carbons themselves, but Goebel, when he made carbons for the company, made more perfect ones than the company did. The company at first tried to make carbons for themselves, but some way they did not suit. In some way the officers of the company heard of Goebel and

then gave him a trial, and employed him to make carbons for them.

August F. Heger deposed that he was a glassblower by trade, and in 1881, early in May, was employed by the American Electric Light Company at their factory No. 104 Centre street. He stated that on the same day he started to work for the American company Adolph Goebel was also employed, and that through him he became acquainted with Henry Goebel. His work for the American company consisted of glassblowing, sealing lamps and work of that character. The American company at first had considerable trouble in procuring carbons for their lamps. It was because of this trouble that they hired Henry Goebel to make carbons for them for a considerable time. These carbons were put into lamps and sold by the American company to its customers. He had himself put many of these carbons made by Mr. Goebel into lamps. The carbons he had put into lamps at Goebel's store were carbons Goebel had made at his place in Grand street. These were good carbons and made good lamps. Had seen Goebel making these carbons at his store; he was very skillful in making them. Had also seen him doing glassblowing work of one kind and another; he appeared to be well acquainted with that kind of work, and did it very well; remembered that at about that time Goebel showed him some old lamps which he had and kept in his safe, among them some that had straight carbon burners. He told him (Heger) that he had made these lamps himself. These lamps referred to were just like the lamp in the photograph shown, the photograph being marked on the back "Goebel lamp No. 3."

Charles G. Perkins deposed that he was the person from whom the Perkins Electric Company took its name, and that he was at present working under contract with that company, and says as follows:

"I know Henry Goebel, of New York City, and became acquainted with him in the latter part of 1880. I first met him through a man in my employ. I was at that time in the business of making incandescent lamps. I was of course very much interested in doing everything I could to improve my lamps, and was on the lookout for any information to assist me. One of my employees told me one day of a man named Henry Goebel, who had a shop on Grand street, and made incandescent lamps, and seemed to know a great deal about them. At that time I had never seen any other incandescent lamp except those our company had made. I went to Goebel's place, introduced myself to him and told him I was interested in incandescent lamps, and asked him to show me the lamps he had made. This was about September, 1880. He showed me in my first interview about three or four incandescent lamps; some of them were made with a tube of glass, others with a pear-shaped bulb. These lamps were made entirely of glass, which Mr. Goebel told me was exhausted of air. They had very small carbon burners, and some of them had platinum leading-in wires. One of these lamps had a straight carbon, such as might be called a fiddle bow carbon, and the others had carbons made in the form of a loop, just as they are made to-day. These lamps all had crossbars of glass connecting and supporting the platinum wires inside the tube or bulb. I have examined the photograph marked "Goebel lamp No. 3" and the lamp with the straight carbon, which I saw at Goebel's shop in 1880, which is just like the one shown in this photograph. Mr. Goebel at that time told me that he had made incandescent electric lamps like those shown me for years and years; I think he said he had made them for more than twenty years. Mr. Goebel seemed to know a great deal about the subject of incandescent lamps, and had a great deal of information which struck me at the time as very valuable. I distinctly remember that I was very much astonished to find he had so much knowledge on the subject. He seemed to me to be a thoroughly practical man. I said to Mr. Goebel that in my work I had had trouble with the lamps cracking. He said to me that the thinner the leading-in wires were the less were the chances of the glass cracking, and that if the carbon burner was made very small and of high resistance, the leading-in wires could be made small and the liability of cracking thus reduced. He told me at the same time that platinum and glass were about the same in respect to expansion and contraction, and that platinum leading-in wires were the best form of leading-in wires. He said he had used different kinds of leading-in wire, but that platinum leading-in wires were the best. Goebel therefore advised me to make my carbons smaller in cross-section and longer, and then the resistance would be higher and the platinum leading-in wires would not be heated so much, and would not be so likley to crack the glass. Mr. Goebel gave me some bamboo at this time to make carbons out of. I made some from this bamboo, making the carbons very small in cross-section and longer—just as Goebel had told me to do—and I was very much pleased with the result. I then asked the firm of Bliss & Williams to make me a die, by means of which I might make the strips for my burner smaller and longer and make them more regular. I used this die in my business and succeeded in making lamps having twice as great a resistance as any lamps I had made before. At the same time Goebel showed me the glass mercury pump which he used for exhausting his lamps. He also told me how to carbonize the filaments. He told me to wind bamboo over a piece of carbon of the shape in which I wanted my carbon, and then carbonize it. I did this at my shop and the results were very satisfactory. I made about six lamps which were tested at 120 Broadway, and which burned very successfully. Goebel at the same time showed me a number of filaments which he had carbonized and which he said were made from bamboo. Some of these filaments, as well as some of the filaments in the lamps he showed me, were about the same in cross-section as the filaments that are used to-day in 16 c. p. lamps, and some were larger than that. Some of these filaments were as small, according to my best recollection, as one one-hundredth of an inch. I called on Goebel a good many times in 1880 and 1881. I remember seeing some planers he used in making bamboo filaments. In 1886, or about that time, I called upon Mr. Goebel, and, seeing some of his planers, I asked him if he would sell them to me. He sold me three, two of these I produce and mark "Goebel No. 7" and "Goebel No. 8." The third I still have in my possession and will produce it later; I could not find it to bring it with me to-day. I remember seeing Goebel blow glass at different times when I called on him, and I remember he was very skillful in blowing glass.

Thomas C. Engelbrecht, Tompkinsville, S. I.; Patrick Griffing, of 228 Monroe street, New York City; John Breen, of New York City; Edward F. White, of 6 Monroe street, New York City; John B. Kurst, New York City; Michael Madigan, New York City; Charles F. Reinmann, of Brooklyn; Wm. Dunn, of Brooklyn; August Verner, of New York City, and Patrick Driscoll, of New York City, all testified to having seen on one or more occasions Goebel exhibit his telescope in public, and that they had never seen, on any occasion, any electric lamp connected with the telescope or used on the wagon, or exhibited in any other manner by Mr. Goebel or his sons.

Albert Hetschel, of Boston, Mass., made an affidavit to the effect that in 1879 he was employed at Menlo Park

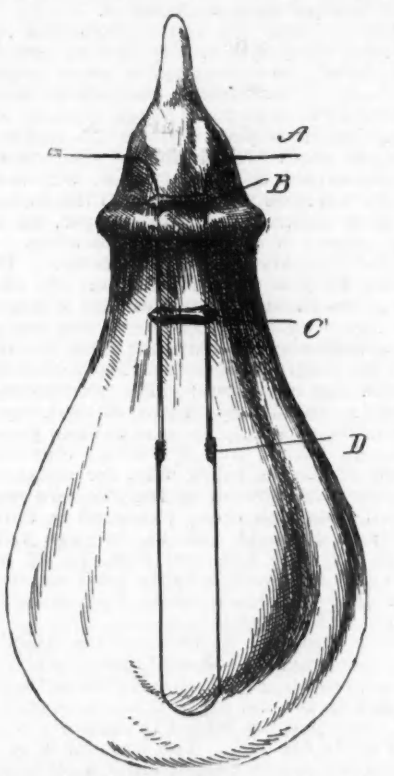


Exhibit Marked "Goebel No. 5."
A C.—Platinum leading-in wire. *C D.*—Copper connecting wire.

with Mr. Edison, and in 1880 he went to work with the United States Electric Light Company, New York City. In 1881 he went into the employ of the American Electric Light Company, which had a factory in Church street, New York. He was employed to go with and to help a man named Henry Goebel. He found that Goebel was undertaking to make lamps for the American company. He stayed in Mr. Goebel's shop several months, and was there working every day and all day, and became very intimate with Mr. Goebel and his family. He found that Goebel knew very little about lamp manufacturing, and did not give any evidence or make any statements to the effect that he had ever had any experience in making incandescent lamps. He never succeeded during the time in which Hetschel was with him in making any good carbon filaments of any kind. Hetschel blew a few small bulbs for him, into which he (Goebel) put carbon filaments which he had not made himself, but which he took out of some Maxim lamps. These four little lamps he hung up in his shop and exhibited them as samples of the lamps that he could make. He did not intimate or say that he had any incandescent lamps in his possession up to that time.

Mr. Otto Moses, New York City, stated that early in 1884, being desirious of making a lamp which, in his opinion, did not infringe upon Mr. Edison's, he visited Henry Goebel at his store in Grand street, and became very well acquainted with him. During subsequent visits, Mr. Goebel showed him all he had done in the way of making incandescent lamps, and all the apparatus which he had for that purpose. He never at any time showed him any lamp like the No. 3 exhibit lamp or any other lamp containing the essential elements of the Edison, which he pretended had been made before the date referred to.

Dr. L. K. Boehm testified that from 1871 to 1878 he was a pupil and assistant of Dr. Heinrich Geissler, of Germany, who was the inventor of the mercury air pump and the Geissler tubes. In August, 1879, he became assistant to Thomas A. Edison. After this he became connected with the United States Electric Light Company, and an assistant of Hiram S. Maxim. In the middle of 1881 he became superintendent and electrician of the American Electric Light Company, which was at

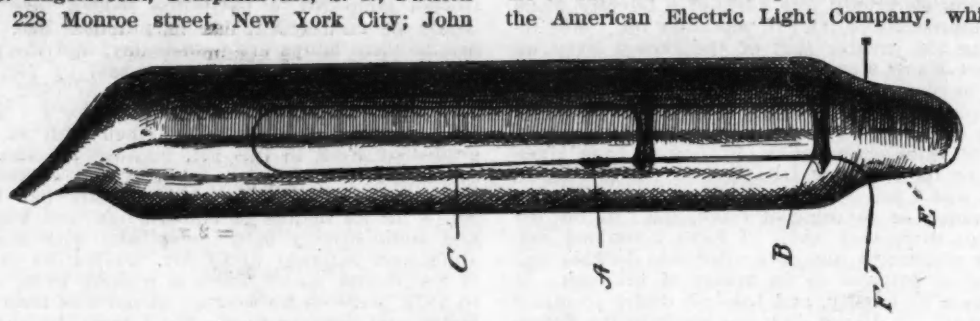


EXHIBIT MARKED "GOEBEL NO. 4."
F E.—Platinum leading-in wire. *E A.*—Copper connecting wire. *C.*—Carbon Filament.

that time at No. 164 Centre street, city. It was there that Dr. Boehm invented what has been known since as the "ground stopper" lamp. The American company then removed to Church street. It was while he was with this company that Dr. Boehm made the acquaintance of Henry Goebel, who came there occasionally, one of his sons being in Boehm's employ as a workman. Dr. Boehm had several conversations with Goebel, and once called at his place of business in Grand street. During such conversations, Mr. Goebel never mentioned that he had made an incandescent lamp prior to Edison's invention. From his personal acquaintance with Mr. Goebel, and what he learned about him afterward, Dr. Boehm got the impression that he was eager to obtain money, and that if he had such a valuable and important invention he certainly would have brought it to the attention of the officers of the American Electric Light Company. In reference to the affidavit of D. C. Voss, Dr. Boehm stated that Mr. Voss was in his employ in the carbon department of the American company's works, that he knew him well and had given him financial assistance. Mr. Voss had often talked with him about incandescent lighting, but he had never at any time said anything about the lamps which Mr. Goebel pretends to have made. Dr. Boehm stated that he had examined the three exhibits of Goebel lamps Nos. 1, 2 and 3. As he had been a pupil of Dr. Geissler he was certainly well acquainted with Geissler's invention, and up to the time the Geissler tubes were invented, in 1860, experimenters had not had at their disposal the means and apparatus for producing a vacuum in the separate chamber sufficiently high to allow the filamentary carbon to last, and, further, that there is nothing on record by which it can be shown that there was anything previous to the Geissler tubes whereby electric currents could be introduced into glass vacuum chambers, and prior to these inventions the state of the art was not such as to enable the production of such results as are claimed by Mr. Goebel to have been obtained early in the fifties. Further, the lamp chamber of Mr. Goebel's is imperfect for two reasons: First, he uses iron and copper wires as leading-in conductors; second, the lamps show very poor workmanship. In reference to the affidavits of Prof. Cross and Franklin L. Pope, who state that the concavities prove that there had been a vacuum in the lamp before it was cracked, Dr. Boehm stated that such concavities can be produced or rather are produced by a partial vacuum only. These concavities can even be produced with the aid of an air pump. Further, it is a well known fact that glass can be blown up into bulbs and concavities can be blown in by the glassblower with great ease. The conclusion is that Mr. Goebel did not use a method of exhaustion which is capable of producing a good vacuum. Third, that the lamp chambers, as shown by the Goebel exhibit lamps, would not hold a good vacuum, and, further, that the lamps shown as exhibits did not show any evidence that any one of them ever contained a good vacuum. The Goebel lamps shown did not present the aged appearance which is well known to glassblowers, and which glass tubing lying for years where dust and atmospheric influences can act on it show.

Affidavits were also made by John W. Howel, Newark, N. J.; Frank Holzer, Harrison, N. J.; William McMahon, Rahway, N. J.; and Timothy G. McMahon, Windsor, Vt.

Note.—Goebel lamp No. 5 is a lamp of modern appearance consisting of a glass globe, pear-shaped, platinum leading-in wires introduced at the side and extending up within the chamber through two glass bridges for a distance of about two-thirds of an inch to the top of the upper bridge; the connecting wires are of copper, extending still farther—about two-thirds of an inch—and there sealed to the carbon filament. One noticeable feature of this lamp is that its larger end is perfectly rounded, not having the boss so characteristic of the Edison lamp of the present day. The lower end, however, has that same boss, indicating that the custom at that time was to exhaust from this end instead of from the other.

Electrical Oscillations of High Frequency.—II.

BY ERVIN S. FERRY.

These induction effects may also be obtained when there is no connection between the resonator and secondary circuit of the induction coil. This secondary circuit, including its condenser plates and discharge gap, may be called for brevity the exciter or oscillator. Hertz arranged his apparatus as shown in Fig. 2.

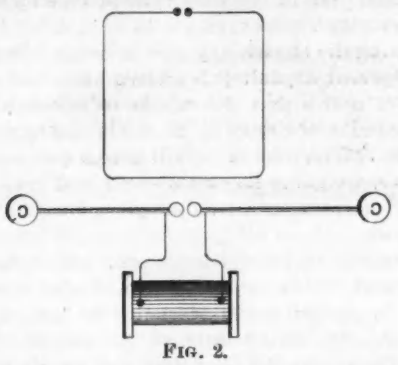


FIG. 2.

The induction coil is connected to two brass rods, each abont one metre long, having at the middle point a spark gap of about .75 centimetre, and near the ends two zinc spheres of 15 centimetres radius, to supply the necessary capacity. The spark gap is bounded by two brass spheres, perfectly polished, about three centimetres in diameter. When, now, the coil is set into action, sparks will leap across the air gap and electrical oscillations of a definite period will be propagated throughout the neighboring medium. There can now be found a resonator of such a length that its period of electric vibration will be equal to or a multiple of that of the exciter; and this will produce sparks in its air gap whenever placed in the field of force near the exciter. The resonator used with this particular exciter was formed of a piece of wire about three metres long, bent into a rectangle, and was provided with a micrometer spark gap. When placed so as to nearly touch the exciter, sparks were obtained in the micrometer air gap of 7 millimetres. As the resonator was moved away the length of the sparks decreased, but they were still visible at a distance of three metres. When a non-conductor is placed between the excitor and resonator the sparks in the latter are unaffected. That the action is not due to electrostatic forces is shown by the fact that if the spark gap of the exciter be increased till no sparks jump across, no action occurs in the resonator, notwithstanding the fact of the greatly increased static potential difference at the terminals of the exciter. The same thing can also be shown by joining the terminals of the resonator by a wet string when sparks are occurring.

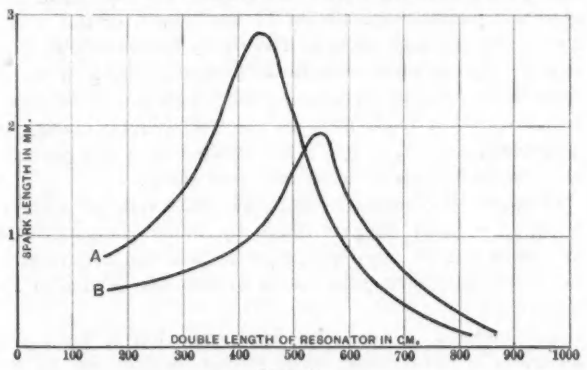


FIG. 3.

Several things must be attended to in order to obtain the maximum length of spark in the resonator. The period of the resonator and that of the exciter must be in accord. This depends upon the self-induction and capacity of the two circuits. The self-induction can be altered by varying the length of the circuits—in the exciter by moving the condensers back and forth in the rod cc', and in the resonator by employing the scheme used in the Cornell Physical Laboratory of having the sides of the rectangle telescope. This is done by using closely fitting rods and tubes. The capacity of the exciter can be easily varied by using instead of the sphere either a sheet of firm metallic foil rolled up like a curtain, or a cylindrical or plate condenser capable of telescopic extension. The simplest way to vary the capacity of the resonator is to attach pieces of wire bent into the form of hooks near the spark gap till the sparks attain a maximum length.

Hertz has investigated the effect of the self-induction and capacity of the resonator upon the spark length. This effect was determined by using several resonators of different lengths, made of the same sized wire, and measuring the maximum sparking distance of each resonator. By plotting spark lengths as ordinates and the double length of resonator as abscissae, he obtained curve A, Fig. 3. The effect of capacity was eliminated by using as a resonator a rectangle having two sides made of wire in coils which could be gradually pulled out, making the resonator of greater length without changing the capacity. The values obtained in this way are plotted in curve B, Fig. 3.

If the sparks in the micrometer circuit are due to a standing wave produced by resonance, we would expect that at some point in the circuit there would be a node or place of minimum disturbance. For instance, adjust the micrometer circuit to unison with the exciter and then increase the length of the spark gap to the greatest distance that sparks will occur. If now one will touch different parts of the circuit with a body of considerable capacity, as with the finger, the sparks will cease except when the place of contact is diametrically opposite the spark gap. Hence there are two nodes in the resonator circuit, one at the spark gap and one diametrically opposite. The space between these nodes has been explored, and it has been found that midway between them is the maximum value of the wave or the loop. The length of the resonator should, therefore, be the same as the wave transmitted by the exciter, or an even multiple of wave lengths.

Sir William Thomson has deduced mathematically the length of the period of oscillation from the discharge of a Leyden jar to be

$$T = 2\pi\sqrt{LC'}$$

where L is the coefficient of self-induction in absolute electro-magnetic units, and C' the capacity in electromagnetic units. Lorentz* has shown that this equation holds equally good for open circuit oscillators produced by induction coils. If C' is the capacity in electrostatic measure

$$C' = \frac{C}{V^2}$$

in which V is the ratio between the two systems of units. This gives

$$VT = 2\pi\sqrt{LC}$$

According to Maxwell's theory the ratio between the two systems of electric units equals the velocity of light; therefore, the above expression represents the distance traversed by light during one oscillation, or the length of an electromagnetic ether wave. This gives approximately the length of wire that should be used for the loop constituting the resonator.

On the supposition that the current density is uniformly distributed throughout the material of the exciter, Hertz deduced the value for the coefficient of self-induction‡

$$L = 2l\left[\text{nat. log.}\frac{4l}{d} - .75\right]$$

where l and d represent respectively the length and diameter of the rod of the exciter circuit, and .75 is a constant. If we imagine the currents to be rapidly periodic, the density will be concentrated at the periphery of the rod and the .75 in Hertz's equation will become unity. This is probably more nearly correct, although the difference is not great.

The capacity of a sphere is equal to its radius in centimetres; of a thin circular disc $\frac{2}{\pi}$ times its radius; and for a thin square disc .36 times a side of the square. Since the exciter has two spheres or plates in series, its capacity will be practically half that of the sphere or plate on either end of the exciter.

In several of Hertz's experiments he used for exciters two spheres of 15 centimetres radius separated 150 centimetres by a rod .5 diameter having a spark gap in the middle. These values give $L = 1{,}902$ centimetres and

$$VT = 2\pi\sqrt{1{,}992 \times 7.5} = 751 \text{ cm.}$$

which is approximately the wave length of the oscillation sent out by the exciter. In the calculations of Hertz, he made the obvious mistake of taking the radius of the spheres for the capacity of the exciter, instead of half the radius, and so obtained $VT = 531$ centimetres. To find the period of the oscillation, substitute for V its value 3×10^{10} and we get 2.51 hundred millionths of a second for a complete period.

* Wied. Ann., vii., p. 161. 1879.

‡ Hertz, p. 55.

Suggestions for Metering Devices.—III.†

BY S. D. MOTT.

In 1884, while engaged in working on electric motors for special purposes, I happened to devise a novel form of motors of simple and cheap construction, but of comparatively very slow speed and small power, adapted only for the lightest kinds of work. This device is shown in Fig. 2, a reproduction of an old drawing, in section. It is nothing more than a Faraday disc machine, or rather its converse, the Barlow wheel modified by the substitution of mercury for the conducting metallic disc used in these devices. The volume of mercury is moved around in a circle by the deflective action of a radiating voltaic current acting through and on the confined mercury in a constant and continuous magnetic field. In the mercury was placed a screw, or paddle, the function of which was to transmit the motion of the medium within the motor to the exterior of same by means of a spindle. I may here state that this device was never applied by me to any useful purpose, though while in London a short time after the writer was shown by Mr. Ferranti a dial mechanism attached to similar design of motor for a metering instrument of continuous currents, which at that time it was expected would be a good commercial instrument, and from its ingenious design it did seem as though it would be largely used. To what extent it was used and the expectations realized I am unable to state.

The type of meter shown in Fig. 1 has the important elements of cheapness and simplicity to a marked degree and is somewhat analogous to Fig. 2, in that mercury or any liquid susceptible of electro-inductive influence is substituted for the usual metallic conductors, but the principles of their action differ widely, and may be stated as follows: When the mercury (Fig. 2) is carrying currents which cut the lines of magnetic force at right angles, the conductor, as is well known, is given a deflective tendency which in this case results in a circulatory motion, to the right or left, clockwise or counter-clockwise, according to the direction of the current, whether it be from the centre to the circumference or vice versa, the field remaining constant and unchanged. If the flow of current and its direction were unchanged, then the direction of the lines of force would determine the direction of the movement of the mercury.

In Fig. 1 the movement of the mercury is due to the preponderating repulsive action of opposite (as to direction) parallel currents induced in any receptive medium properly disposed in an alternating field, predominating over induced parallel currents, which are not opposite but in the same direction to the amperian currents of magnet, producing the alternating field of force; in other words, "there is a repulsion due to the summative effects of strong opposite currents for a lengthened period, against an attraction due to the summative effects of weak currents of the same direction during a shortened period, the resultant effect being a greatly preponderating repulsion."

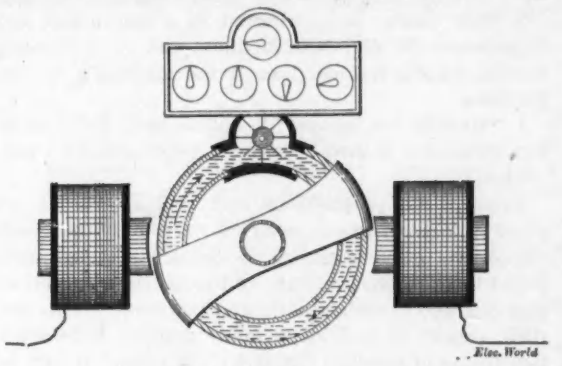


FIG. 1.

The investigation and demonstration of the phenemena of alternating current induction as applied to the production of motion and the laws bearing on the same are due to the researches and ingenuity of Prof. Elihu Thomson. This able experimenter has shown many mechanical arrangements to produce continuous rotation by direct torque or deflective action, and Fig. 1 is an adaptation from his experiments. It consists of a direct reading mechanism, which takes its motion from a fluid meter or Archimedean screw, which in turn takes its motion from the circulating medium, which in this case is mercury.

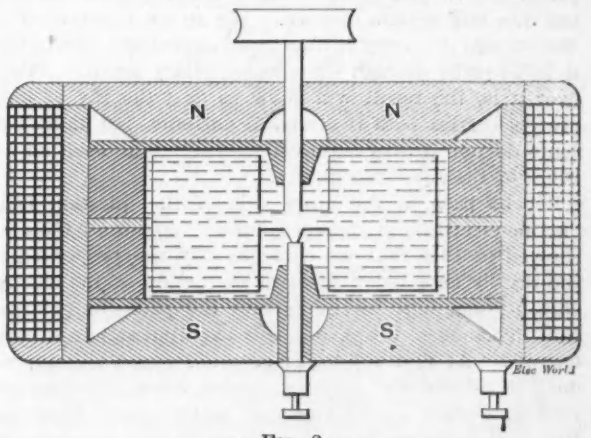


FIG. 2.

The band or shield is for the purpose of shading from the influence of the alternating pole a portion of that part of the apparatus to which motion is to be imparted through the direct influence of the pole. The polar induction is absorbed within the shield, and is intercepted from any influence upon the material which it encompasses.

The relative proportions, positions and arrangements of the apparatus may be greatly varied; it might be well, for instance, to place the magnets out of line so that their axes do not lie in a plane passing through the centres of circular inductometer, i. e., that on the right may be advantageously lowered, and the one on the left raised.

The shield may have a circumferential adjustment for calibrating the meter, though there are a number of ways and means which lend themselves to the purpose.

If the friction between the mercury and the glass were found a detrimental feature, I see no reason why some form of lubricant, as graphite, would not be entirely suitable to place inside the tube.

Various modifications of this device and many designs of motor having the features of a circulating medium receptive to magnetic induction will suggest themselves to those skilled in the art. The action of a fluid receptive to electro-inductive repulsion under the influence of an alternating field causes a motion of the fluid in the direction of the arrows; this circulation is measured and totalized by means of a counter or registering mechanism under the assumption that the indications obtained from the dial will correspond without material change to the actual consumption of electrical energy.

† For parts I. and II. of this article see THE ELECTRICAL WORLD of Jan. 14, 1893, page 26, and Jan. 28, 1893, page 63.

Ether and Electricity.—Part III.*

BY A. STOLETOW.

What is said above of metals cannot be literally applied to compound conductors (generally liquids) which are decomposed by the current. These bodies (electrolytes) are middle terms between metals and dielectrics, and they are generally in a closed circuit, the sources of the current, the transformers of chemical into electrical energy. Where does this transformation take place? Where is the electricity produced? This question has never been satisfactorily answered. Lodge thinks that the lines of electrical energy start from the surface of the immersed zinc plate in a voltaic cell.

Let us now resume our considerations:

1. Dielectric bodies, or rather the ether which fills them, are the propagators of electromagnetic energy.

2. This energy is distributed in a continuous manner throughout the dielectric medium, and on it depends the movement and deformation of the medium's elementary particles.

3. "Metallic conductors" do not conduct electrical energy but transform it into heat, as it penetrates into the conductor.

These three propositions still remain true if we replace "electromagnetic energy" by "radiating energy." These two forms of energy, so distinct in appearance, are found in the same medium, and each has a special molecular character, both kinetic and potential. Can we not, then, expect to find an intimate relation between these two forms of energy? Could we not cause electric action by a ray of light or a ray of light by means of electrical phenomena? This question, of course, refers to immediate tranformations, because we already know that every form of energy can be changed into some other form.

The thermo-electric device of Melloni shows us already that rays of light may become the cause of a current. But here the radiant energy is first transformed into heat in the solder and the current is only indirectly produced. We should obtain the current by any other method of heating the solder. The experiments of Becquerel and others have proved that any two metals in an electrolytic fluid form a galvanic couple when light is thrown on them. The details of this experiment make one think that this intermediary causes chemical action to take place.

But it is especially in the air and, in general, in gases, that these phenomena are striking. Rays, especially ultra-violet rays, charge positively a neutral body, and discharge one charge negatively. We observe this action with all sorts of bodies, liquid and solid, and in very different gases; the only condition being that the outer surface of the body shall absorb active rays. These phenomena have been studied for the first time by M. Hertz (1887), and since then by several other savants, but they still remain obscure. We do not know whether this change of energy is direct and immediate, or whether it takes place through some intermediary agent. Whatever it is, the result will show us that the ray of light always carries with it electrical currents, but these currents do not always manifest themselves as such on account of their peculiar nature.

Let us pass to the other side of the question from "actino-electric" to "electro-actinic" effects. Faraday showed in 1845 that we could modify the properties of the ray by submitting them to the action of the electric current; magnetic forces deviate the plane of polarization in Crookes' tubes, but this experiment is not clear energy? At first sight this question seems useless; we do it in all electric lamps; a current raises the temperature of certain conductors and makes them luminous. But here again we have an indirect change, which is not what we are after. Perhaps there is a direct transformation in Crookes' tuges, but this experiment is not clear enough. Is there any means of giving to the propagation of the electric current a form which shall resemble a ray of light? Maxwell, in 1865, approached this question theoretically, and found an important result. After having given a mathematical form to the laws of the electromagnet, Maxwell queried:

How can an alternating current pass through a dielectric medium? The Ruhmkorf coil, the alternating currents of a dynamo, the telephone, and the mechanical vibrations of charged bodies give examples of this kind of current. Each of these devices may serve as a source of perturbations (electromagnetic) in the ether of surrounding medium. What is the method of transmission of these perturbations?

And this was his answer: The energy is propagated in a transverse wave with a speed that depends on the electromagnetic properties of the medium. Along each line from the source of these alternating currents are propagated successively similar currents or "periodical vibrations of electricity," whose direction is perpendicular to these lines.

1. The electrical force, which is developed at the same time, is directed along these oscillations (vibrations); magnetic force makes a right angle with them. The three lines—the line of propagation, the line of electric force, and that of magnetic force—are interperpendicular. (We have already seen how this takes place in each electromagnetic phenomena.)

2. In calculating the speed of this propagation of the electric wave in the ether of air, or what amounts to the same thing in free ether, we find it to be 300,000,000 metres a second. Now, this is also the velocity of light in the same medium. For other transparent bodies, the velocity of light propagation is inversely proportional to the index of refraction; for electric waves it ought to be theoretically inversely proportional to the square root of the dielectric coefficient of the medium. But if we compare the index of refraction with the square root of the dielectric coefficient (we know them both by experiment), we find that they are almost equal. For gases and other perfectly dielectric bodies, sulphur, petroleum and paraffine, the coincidence is exact. For less perfect dielectrics (granting the principle of absorption), and especially for electrolytes, the numbers do not coincide for special reasons; but this difference disappears when we measure the coefficient by means of dielectric currents that are sufficiently rapid. When we examine crystals possessing the property of double refraction, in which the velocity of light propagation changes with the direction, we notice the same changes for electricity.

We come in general to this conclusion, that the velocity of electric wave propagation and that of light are equal in the same bodies, in the same directions and for the same length of wave.

These striking results have been predicted from theory and discovered by Maxwell. Until recently no one had measured by direct experiment the velocity of electric wave propagation. They found its value from the value of the dielectric coefficient. No one had observed the transmission of the electric wave through dielectric matter.

It remained to prove these prophecies of theory. This important victory of science was achieved by the experiments of M. Hertz in 1888 and 1889. The difficulty of the problem seemed insurmountable. If the electric wave is propagated with the same velocity as light, it is not likely that we can measure it directly, inasmuch as it becomes extinct to us, at a short distance from the source. It is then natural to have recourse to the interference of waves. Supposing we know the time of vibration, it is sufficient to measure the length of wave to find the velocity of propagation.

But what is the length of the wave?

Mechanical oscillations, which we can produce, have some hundreds, or, at the most, some thousands of vibrations per second. Such are the alternating currents of the Ruhmkorff coils and the telephone. If the electric vibrations are synchronous with mechanical vibrations, the length of the wave must be enormous; thus, for 1,000 vibrations per second it would have to be 300 kilometres long. It is evident, then, that we must assume waves of perhaps millions of vibrations per second, that the length shall be within probability. The question seems insoluble, but it is not so. Electric vibrations might take place without the aid of mechanical ones. Henry claimed in 1842 that the discharge of a Leyden jar was of a vibratory character. This hypothesis was confirmed by the theoretic research of Thomson, and by the optical analysis of the spark of discharge by Fedderson. These vibrations are rapid enough for our purpose. We know that each body has its fundamental; that is, that it can give out sounds of a certain pitch. Each conductor, likewise, has its electrical "fundamental," whose period depends upon the form and dimensions of the conductors. Hertz made use of this fact. To cause very rapid vibrations he connected of small capacity of a Rhumkorff coil to a conductor of small capacity and slight self-induction, of a high electric "note." The discharge of this conductor, which is produced in the form of a spark, has the character of an alternating current of very much smaller period than that of the interrupter of the primary circuit. The interrupter only serves from time to time to renew electric vibrations, as the violin bow keeps up the vibrations of the string. Unfortunately, the interrupter acts too slowly, and in place of obtaining a continuous electrical "note," we have a series of extremely short "notes" with intervals relatively long. It is thus that they have produced vibrations to the number of hundreds and even thousands of millions per second. The length of the corresponding wave is then some metres or perhaps a fraction of a metre. We have thus created a vibrator, the time of whose vibrations we know in advance. But another difficulty presents itself. How are we to collect and show the transmission of electric waves through air? When the wave passes through air, it is not visible nor sensible at all, so we must receive it on another conductor of the same electric "tone," or in other words, upon an electric "resonator." Under the action of the wave of electricity, this conductor will repeat the oscillations of the vibrator as two tuning forks will vibrate sympathetically when in unison. By using as a resonator a metallic wire of convenient size, with a very short space between its ends, Hertz obtained a spark, sometimes bright, sometimes scarcely visible. At a considerable distance from the vibrator (a dozen metres) the action of the wave is very feeble, the spark can pass through an interval of scarcely more than 1-1,000 of a millimetre. The spark lasts only one-millionth of a second, but in spite of all we see it, so sensitive is our sight. After having made his vibrator and resonator, Hertz made the following series of experiments. He shows that an electric wave is propagated in all directions and can be followed for 15 or 20 metres. The wave passes easily through a thickness of wood or stone, as light passes through glass; but it cannot penetrate a metallic sheet, and is reflected by it, causing an electric shadow. Electric energy is propagated in right lines. If we place the vibrator in the focus of a large concave mirror (of white iron), we get a lot of parallel rays, and in collecting these rays in another mirror, we find in the focus of the latter a more brisk action than in the former, as in Pictet's well known experiment with heat rays.

In making the electric ray pass through a prism of electro-transparent asphalt (1.5 metres high, and 1.2 metres thick), we notice that the ray is refracted with almost the same index of refraction as the luminous ray. Lodge has made two enormous asphalt lenses (one square metre in surface, weighing 200 kilos each) and collects electric waves as we concentrate, through a lens, the heat rays of the sun.

The electric wave is transversal, and, therefore, can be polarized, in the optical sense of the word. This is verified by inclining the resonator to the ray more or less. Thus we can imitate all the effects of polarized light. Then, too, like luminous and sound waves, electrical rays can produce the phenomena of interference.

For example, in making an electrical wave fall normally upon a metallic plate, we obtain the interference of the incident with the refracted ray. At certain points (nodes) the resonator is without action. The distance between two nodes gives the length of the half wave and permits us, therefore, to calculate the velocity of the propagation of the wave.

This velocity is actually equal to that of light. In other words, our wave or electrical ray presents the greatest resemblance to the ordinary ray of light and heat and is doubtless transmitted by the same medium.

Have we a resemblance only? Have we not rather an identity in every respect between the two phenomena, except, perhaps, the length of waves?

M. Hertz's wave has a relatively great length. Is not this, then, the only thing that distinguishes it from a heat wave, as a feeble glowing body only differs in the length of its wave from that of the ultra-violet rays of the voltaic arc?

What are the functions of an electric ray? In a resonator, it produces heat and light. Doubtless it can produce, like any other electric current, a chemical effect. But these, we notice, are the functions of the solar ray. The electric ray lacks one thing, it cannot act on the retina. For there does not exist in nature, as far as we know, any eye sensitive to rays of the length of a metre. But rays of heat are not all perceptible either.

It is then natural to admit that the wave of transversal vibrations, produced by an alternating current, and the transversal wave of ether, that we call light, are identical phenomena, almost to the length of the wave. From this we may assume that every luminous and heat ray is only an electromagnetic phenomenon, a wave of very rapid electric vibrations. The radiation of heat is a transformation from heat to electromagnetic energy of a special kind. The eye is an organ which can perceive electric vibrations of a certain periodcity.

In expressing ourselves thus, like Maxwell, we seem to wish to explain simple things by more complex ones. Would it not be more simple to reduce the definition of the electromagnetic phenomena to the clearer idea of the light ray?

The method of heat and light radiation is known to us under a fixed form, while electric action can be put under many forms, among others that of the wave. We must notice, however, that the old idea of the luminous wave (Fresnel's) is too narrow, and does not explain electric vibrations of a certain periodicity.

We may enlarge our idea without sacrificing the essential parts of it. In saying that light is a wave with electric and transversal vibrations, we make an enlargement, but at the expense of clearness. In replacing the old and clear idea of "transversal movement of molecules of ether" by the incomplete scheme of "electric and transversal vibrations of ether," we take a backward step in the theory of light, at least in the simplicity and clearness of it. But, on the other hand, by this slight concession, we introduce at once the whole theory of radiating energy, as a part of the more general theory of electromagnetic phenomena of the general action of ether.

And this is not all. This change is also favorable to the theory of light. Maxwell's electromagnetic theory of light gives a simple solution of some doubtful and difficult questions, in spite of the gap which this new idea of the luminous wave leaves. This gap should surely be filled, but as yet the action of electromagnetism is only partly known.

As long as we cannot tell in a clear manner what goes on in a particle of ether; as long as we shall speak only of "a certain perturbation, a certain vibration," having recourse for greater clearness to "electric vibration"; as long as we cannot know in detail the tracks and invisible wheels of this complicated machine called the electromagnetic field—our intelligence is only at the first step of the ladder. But even here a large prospect is open before our eyes.

We are already far from this vague dream of Faraday, which is asking itself if the radiations should not be only simple vibrations of the lines of force, and which seems

* Translated from the French by Lieut. William W. Harts, Corps of Engineers, U. S. A. For the first and second sections of this article see THE ELECTRICAL WORLD of Jan. 28, 1893, page 62, and Feb. 4, page 87.

frightened at its own voice and confesses that this is only a "shadow of speculation."

The hypothesis of Lodge tries to fill this gap by introducing into the new theory the old idea of Symmer, of two electric fluids. To Lodge, ether is a combination of two substances, positive and negative electricity. Molecular electrification of the medium is a decomposition of its own ether into a sort of "ions"; electrical energy is a sort of chemical energy.

We do not think it is necessary to turn back to these two electric fluids, even under the new form. We do not think we ought to reduce electricity to chemistry. We should wait for something less artificial.

We have neglected one point. We have admitted that the electric ray of Maxwell and Hertz is identical with that of light. Can we prove this? We might if we could give to the electric ray all the properties of the luminous ray (by diminishing the time of vibration of the vibrator), and render it capable of producing the sensation of light. By reducing the size of the vibrator, we approach this end, but to attain it our vibrator must be but a single molecule. We cannot handle a single molecule, so we must give up trying to produce these vibrations scientifically. However, we produce these unconsciously in each electric spark and generally in each source of light, but we cannot prove their electrical nature.

But there is still one point. Does the solar spectrum contain rays of as great wave length as Hertz maintains? It is very probable, and also very likely, that the sun sends us rays situated outside the limit of the infra-red spectrum, which produce no sensible heat effect, but which can act electromagnetically. Perhaps we might explain the magnetic action of the sun upon the earth by these rays. Are not our magnetic storms traces of enormous electromagnetic disturbances of the sun, transmitted to us by these long waves of ether? As to atmospheric electricity, there is already an ingenious attempt (Arrhenius) to explain it by the electro-actinic effect of the short waves of the solar spectrum.

Let us resume what precedes. The electromagnetic energy which is found in electric and magnetic phenomena is the energy of ether which fills all space. It depends upon the deformation and movement of molecules of ether, the details of which are unknown to us. The heat and light ray is one of the forms of this energy. The molecular vibrations of a heated body arouse in ether the same phenomena, only in another length of wave, as is produced by every apparatus which excites alternating electric currents.

By aid of a solar ray as a source of heat, we can run a dynamo with an alternating current and produce a voltaic arc, which, as an electric sun, transmits in its turn a part of its radiant energy into space.

All those principal phases which are presented under the special form of light, in its wider meaning, we might designate as an electromagnetic cycle.

New facts are proving still more the existence of ether and are overthrowing the idea of action at a distance of electromagnetic forces.

The mechanics of electromagnetism comprise that of heat and light, and are, indeed, the mechanics of ether.

In 1881, in the closing assembly of the International Congress of Electricians, at Paris, Dumas called our age the age of electricity. And indeed the period which commenced with the voltaic pile, and is ending with the application of electricity to all the conditions of our life, deserves the name.

But, in the words of Dumas, there was another and further meaning. The mystic word "electricity," in spite of its triumphs and its practical applications, has too long been a reproach to us. It is time that we freed ourselves from this word, that we introduced it in the line of exact sciences. The traditional word might remain if instead of an "asylum ignorantiae" it could be the simple and clear title of a large branch of the world's science.

The end of the century brings us rapidly to this point. The word "ether" has already come to the assistance of the word "electricity," and will soon replace it. The mechanics of ether, which is still far from perfect clearness, but which promises a rapid development, already replaces the old theory of "electric fluids" and the later, but insufficient, idea of "electromagnetic forces." Whether it will untangle other cosmic snarls or not is more problematical, but for electricity a new era has begun. The twentieth century will be the "age of ether."

Home Made Storage Battery for Electric Lighting Purposes.

The question of house electric lighting was solved by the introduction of the storage battery, making it possible to have the electric light far from central stations and without any connections with them, unless the accumulators are taken there to be charged, making it possible, moreover, to use for the production of the current such unsteady and irregular sources of power as water motors, small steam engines, etc., and deriving the current from small dynamos, often amateur productions, which are to be found in many homes throughout the country. In the use of such motors as above mentioned the current delivered would be unsteady, but the current delivered by the storage cell would be absolutely steady. As many would undoubtedly like to install such a plant in their homes or shops, a description of a cheap but efficient storage battery is given, and in a future article will be given directions as to how to make a small dynamo to actuate the same, to help those who do not possess such a machine, and which can be made by hand with as much ease as this storage cell. The storage battery consists essentially of but three parts: the poles or electrodes and the containing jar or cell to hold dilute sulphuric acid (acid 1 part, water 10 parts by volume) in which the plates are immersed. The cell, which is hardest to obtain of any part of a storage cell, should, in this case, be 1¾ inches wide by 12½ inches long and 13

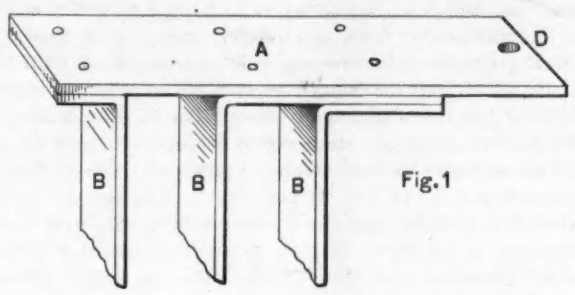


Fig. 1

inches high, inside measurement, and should be of glass if obtainable, if not, one can be made of pine wood thoroughly paraffined inside and well varnished outside. In mixing the solution for the above battery the acid should be poured, in a fine stream, into the water, otherwise, on account of the great heat produced, a part of the acid might be thrown out of the mixing vessel, producing ugly burns and stains wherever it fell. Care should also be taken that the solution before it is poured into the paraffined cell is perfectly cold, as otherwise it might melt the paraffine off the walls of the cell; this it would certainly do, if the acid and water were mixed in the latter.

The poles of the cell described are each composed of

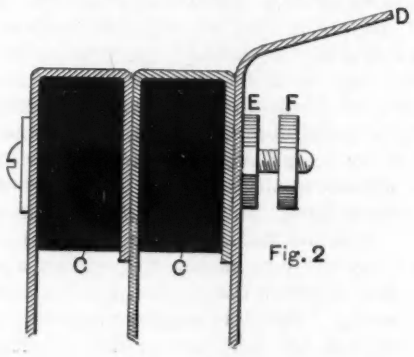


Fig. 2

three lead plates 1-16 inch thick and 12 inches square, with a lug or ear 2½ inches high and 1 inch wide, in one corner, as shown in Fig. 3. These leaden plates, of which there must be six for each cell (three for each pole), must be laid on a smooth pine wood or any other soft wood board and perforated as thickly as possible with 1-16-inch holes, which can be made either with a drill, or, what answers just as well and does the work more quickly, a hammer and nail.

These holes are to be filled with a thick paste of red lead and sulphuric acid, spread on with a wooden spatula, the surface of the plates being also thickly smeared. The plates are then set aside for the paste to dry. When dry, glass beads as a, a, a, Fig. 3 are fastened

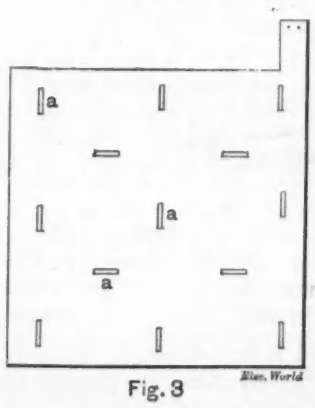


Fig. 3

Fig. 4

to each side of three of the plates. These beads can be made by breaking a piece of No. 8 chemical tubing into short lengths, say 3-16 inch, by making nicks into the tube with a triangular file and breaking between the fingers. These glass beads are to keep the plates from touching, and can be fastened in any of the holes already punched in the plates, by means of paraffined string or rubber thread, as shown in Fig. 4, first punching out of the holes the red-lead paste. In Figs. 1 and 2 are shown two ways of fastening together the three plates that constitute a pole. The lugs B, B, B, Fig. 1, may be bent at right angles and riveted by means of lead rivets to a strip of lead A, as shown, or as in Fig. 2 the lugs may be bent around two blocks of hard rubber, ebonite, fibre or wood even, and fastened together by means of a bolt and nut. Connections between any two cells or with lamps, etc., can be made by mounting binding posts at D, D, or by wire between the nuts E and F. The three plates that have the glass beads fastened to them are riveted or bolted together as above to form one pole of the cell, the other pole being formed of the remaining three plates, also riveted. In setting up the cell the poles are interlocked, as shown in Fig. 5, which will leave about 3-16-inch space between each plate and its neighbor. The poles may now be immersed in the dilute acid and "formed."

To do this connect the storage cell to the terminals of a dynamo or to a 5-cell bichromate battery and leave it in the circuit for four hours, then disconnect from dynamo or bichromate battery and allow the storage cell to discharge itself by connecting its terminals. After

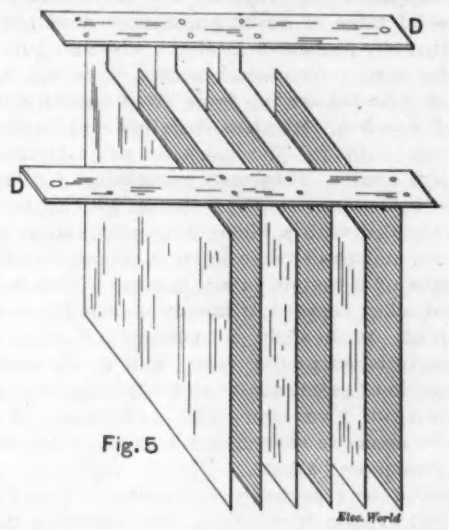


Fig. 5

discharge, connect again with the dynamo, etc., but to opposite poles, so that the dynamo current shall now enter the storage cell where it left it in the first charging.

Discharge and charge and discharge again, and the "formation" of the cell is complete. It will have a capacity of about 15 ampere hours and an E. M. F. of about 2 volts. While the directions above given are as though only one cell was being built, as a matter of course any number of cells could be made at once, in fact, a number of cells would better be made, as with one cell very little can be done. The writer has had in operation for some time a series of 12 such cells which light a couple of 16 candle, 20 volt, Edison incandescent lamps, of 8.3 ohms resistance, for some hours each evening, and do the work well.

An amateur acquaintance of the writer derives the current for his cells from a small dynamo, built by himself, and run by a small steam engine of perhaps ¼ h. p. His cells are rather larger than the above and more numerous, and he charges them once a week or thereabouts, or, running his dynamo for several hours an evening, for two evenings, he has current enough at his command for the balance of the week. This charging requires only the presence of some one to see that steam is kept up; the person might read or work at something else while it is going on. The speed of the dynamo is very irregular and the current, if delivered direct to the lamps, would not do for lighting, but by delivering the same to storage cells it can be taken therefrom as uniform and constant as desired. Not only are a series of such cells very useful for electric lighting, but they do as well in supplying current to electro-motors, fan motors or large bells and gongs, where the duty is too constant and heavy for the ordinary open circuit cells. To ring electric bells one cell of storage battery will usually be found sufficient. It can in such cases be readily charged by Bunsen or bichromate batteries.

A Voice from the Tomb.

A rather pathetic letter, considering the circumstances under which it was written, has been received by the editor of The Electrical World, from a convict undergoing a life sentence in the Dorchester Penitentiary, Westmoreland county, New Brunswick, which shows how The Electrical World brings pleasure into a life almost devoid of hope, and how the interests which moved the man in the busy world still agitate his mind amid his sombre surroundings. Without money or the means of obtaining it, and his subscription to The Electrical World having expired, he writes as follows: "You cannot imagine how sorry I feel to be obliged to give the paper up, for I wanted to see the new Westinghouse lamp, and how it is going to affect the General Electric Company. This latter has permission, as Portia gave to Shylock, to take his pound of flesh, and I have been looking to see if it draws blood in cutting the cuticle. I do not wish you to get a bad opinion of me, for enough people have already held that without my increasing the list, so I write you this letter to explain why I have not renewed my subscription, as I think it the most honest way I can deal with you; and wishing you all the success you may wish in the future, I resign myself to the inevitable, and remain,

"Faithfully yours,

"* * * *"

THE ELECTRICAL WORLD'S DIGEST OF CURRENT TECHNICAL ELECTRICAL LITERATURE.

(Compiled from the principal foreign electrical journals)

BY CARL HERING.

ELECTRO-PHYSICS.

Striking Distances for High Potentials — In the "Elek. Zeitschrift" of Jan. 20 Dr. Heydweiller gives a very useful table of striking distances determined both experimentally and theoretically. The first part of his paper describes a theoretical method of calculating these distances founded on the laws given by Kirchhoff and those of Paschen. He then describes and illustrates an instrument built for the purpose of verifying these theoretical results. It consists essentially of a horizontal bar bent something like the letter S, with knobs at each end, suspended with a bifilar suspension, so as to move in a horizontal plane; each knob is opposite and near to the centre of a metallic ring, toward which they were attracted when charged; a mirror enables the deflections to be read. With slight corrections the potentials are very nearly equal to the square root of the deflections. It is capable of measuring from 5,000 to 50,000 volts with an accuracy of 1 per cent. The calibration and graduation were made by comparison with a Kirchhoff-Thompson electrometer balance.

Its action was perfectly satisfactory. The following tables will explain themselves. The values in the table, he states, can be relied upon as being correct within 1 per cent. The barometric pressure and the temperature have quite a considerable influence on these sparking distances and must therefore be introduced if accuracy is required. For every 8 millimetres increase of the barometer reading and for every 3 degrees C. lower temperature the values should be taken 1 per cent. greater. It is also recommended not to use striking distances greater than one centimetre for the small electrodes and to use larger electrodes the greater the potentials. Care should be taken that there are no bodies near the knobs, as they will alter the conditions; the well known spark micrometer, for instance, gives incorrect results for sparks greater than the diameter of the knob, on account of the various parts of the instrument:

TABLE I.—SPARKING DISTANCES IN AIR FOR HIGH POTENTIALS BETWEEN TWO SPHERICAL ELECTRODES OF EQUAL SIZE AT 745 MILLIMETRES BAROMETRIC PRESSURE, AND 18°C. TEMPERATURE.

For electrodes of 0.5 centimetre diameter.

Centimetres.	Volts observed.	Volts calculated.
0.1	4,800	4,800
0.2	8,400	8,600
0.3	11,300	11,400
0.4	13,800	13,700
0.5	15,700	15,500
0.6	17,200	17,000
0.7	18,300	18,100
0.8	19,000	19,100
1.0	20,200	20,500
1.5	22,300	22,700
2.0	23,200	23,800
3.0	24,300	25,100
4.0	24,900	25,700
6.0	25,700	26,000

For electrodes of 1.0 centimetre diameter.

0.1	4,800	4,500
0.2	8,400	8,400
0.3	11,400	11,900
0.4	14,500	14,900
0.5	17,300	17,700
0.6	19,900	20,000
0.7	22,000	22,100
0.8	24,100	24,000
0.9	25,600	25,600
1.0	27,000	27,100
1.5	31,800	32,500

For electrodes of 2 centimetres diameter.

Centimetres.	Volts observed.	Volts calculated.
0.1	4,700	4,100
0.2	8,100	7,900
0.3	11,400	11,400
0.4	14,500	14,800
0.5	17,500	17,900
0.6	20,400	20,800
0.7	32,200	23,600
0.8	26,000	26,200
1.0	31,300	30,900
1.2	35,500	35,000
1.4	38,600	38,700
1.6	41,300	42,000
2.0	47,500	47,500

For electrodes of 5 centimetres diameter.

0.5	18,400	17,800
0.625	22,300	21,900
0.75	26,100	25,900
0.875	29,500	29,800
1.00	32,800	33,400
1.125	36,300	37,000
1.25	39,700	40,500
1.375	43,200	43,900
1.5	46,200	47,200
1.6	48,700	49,600

For higher potentials and striking distances than those given in Table I., Table II. has been prepared, in which the values are calculated, but have not been verified by experiment. He states that it may be relied upon within 4 per cent:

TABLE II.—BAROMETER 746 MILLIMETERS. TEMPERATURE 18° C.

For electrodes of 10 centimetres diameter.

Centimetres.	Volts calculated.
1.0	33,000
1.5	48,000
2.0	61,000
2 5	75,000
3.0	87,000
3 5	99,000

For electrodes of 10 centimetres diameter.

Centimetres.	Volts calculated.
4.0	110,000
5.0	129,000
6.0	147,000
7.0	162,000
8 0	175,000

All these potentials refer to gradually increasing voltages; whether they are correct for rapidly alternating potentials remains yet to be determined. It is known that liquid dielectrics change when subjected to an electric strain for a long time; whether the air has a similar property or not has not yet been determined. The values given in the tables are sufficiently accurate that they may be used as a measure of high potentials provided they are not alternating.

Mercury Arc Lamp.—Mr. Arons, before the Physical Society of Berlin, describes a curious and interesting arc between mercury electrodes. A U tube of glass two centimetres in diameter and whose arms are each six centimetres long, has its ends closed and has platinum wires fused through the glass. At the curvature is fused a glass tube which is curved so as to form a mercury seal and communicates with a mercury pump. For experimental purposes this latter tube is also provided with a branch which may be connected to a manometer, or may serve for the introduction of gases. The U tube is filled with mercury nearly to the level of the curvature, so that the two surfaces of the mercury are about three or four centimetres (1¼ to 1½ inches) apart. (Although not stated it is evident that the U tube is inverted, with the curvature at the top.) The air is then exhausted to any desired pressure, and the branch tube is sealed with mercury. The current is led into and out of the tube by means of the platinum wires, and to prevent heating, for large currents, the ends of those tubes are placed in vessels containing mercury. The arc is started by shaking the tube so as to establish a momentary contact between the two columns of mercury.

When the vacuum is less than one millimetre the voltages corresponding to various currents were as follows:

Volts..	17.5	17	16 5	16	15.3	14	20	28	40
Amperes..	11	9	7	5.5	5	2	1.4	0.8	0.5

For the smaller currents it is necessary first to use a larger one and then reduce it. For currents greater than 1.4 amperes the whole tube is filled with a very intense, gray light. Although the light appears continuous, the discharge in the tube is discontinuous, which may be shown by the aid of a telephone, and for this reason it is necessary to use electromotive forces nearly three times greater than the difference of potential at the electrodes. (Although not stated, it is evident that continuous currents were used.)

Contrary to what is found in the ordinary arc lamp, the negative pole heats up more than the positive. The presence of gases does not materially change the conditions, but the temperature becomes greater and the arc does not fill the whole section of the tube, but is limited to a luminous band. In using zinc amalgam or by placing pieces of aluminium in the mercury, the heat becomes so great that the tube melts. For sodium amalgam the positive pole becomes the hottest, but the currents may be more easily reduced to smaller values.

He examined the spectrum of this mercury arc and states that the energy of vibration of the characteristic waves ought to be very great considering the excessive brilliancy of the light. A list of the lines observed in the spectrum will be found in "La Lum. Elec.," Jan. 7, p. 42.

By placing the whole apparatus in water, the lamp can be run for hours with currents of nine and ten amperes. The temperature of the arc itself is not very high; a thermometer introduced into the arc shows a temperature of boiling mercury after three minutes.

(It is to be regretted that the author does not give the intensity of the light, so that some data could be obtained of the efficiency. Possibly the original paper, which we have no access to, gives this, though it is not likely. A curious feature is that the voltage remains nearly constant, while the amperes vary from 11 to 1½; also that the voltage is quite low.)

Experiments with Induction Coil Currents.—Mr. Maclean, in a paper read before the Philosophical Society of Glasgow, investigated the subject of the direct and indirect secondary currents in an induction coil, and described some attempts to measure these currents. Speaking of the currents induced in the secondary, when that in the primary was made and that when the primary was broken, he says that the quantity of electricity in the secondary was the same for both, but the durations were quite different. Fig. 1 shows this more clearly. A B represents the time during which the inverse make current lasts and B C the time during which the direct break current lasts; D E and F G represent the maxima; the area A D B A is equal to B F C B. That the two are equal was experimentally proved by Faraday, and was subsequently corroborated by theory and experiments.

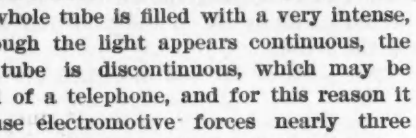


FIG. 1.

If, however, there is a non-metallic gap in the secondary circuit, whether of air at ordinary pressure or at greatly reduced pressure, as in vacuum tubes, the break impulse causes a flow in one direction, while the make impulse causes either no flow or a much less flow in the opposite direction, the explanation being that the short intense impulse of the former breaks down the resistance, while the other does not or does so to a much less degree; the effective resistance is, therefore, much greater in one direction than in the other. To measure the average quantity of electricity passing in one direction above that in the other he inserted a copper voltameter in the secondary circuit in series with a vacuum tube. He gives the results of seven experiments (see the Lond. "Electrician," Jan. 20, p. 325). They lasted from one hour to five hours; the average current was one-sixth of a milliampere; with one exception, which could not be explained, the gain of one electrode was greater than the loss. The ratio of the primary and secondary currents was as 6,000 to 1. He next inserted a resistance of one megohm made of copper sulphate in a glass tube to take the place of the vacuum tube; there was no air gap; the results were inconclusive. With an air gap in place of the vacuum tube the results obtained were similar to those with the vacuum tube. With nothing in the circuit but the voltameter both plates showed a loss.

(The well known fact that the pressure of the break current is greater than that of the other can be shown by the simple method of placing a Leyden jar near to one of the terminals, but not touching it; the jar will soon become charged, showing that the pressure of one of the currents is great enough to cause a spark to pass across the air gap to the jar, while that of the other is not. This method may be made use of to obtain very high voltages from a single cell, to replace the water batteries formerly used for testing insulation.)

Referring to the experiments made by Mr. Swinton with high frequency currents (see The Electrical World, Jan. 28, p. 64), he adds in the Lond. "Elec. Rev." that practically no sensation is experienced when the body is introduced so as to form a circuit between one pole of the coil and the earth; but when the body is inserted between the two poles of the coil the sensation is very severe and quite unbearable. It is curious to note that the physiological effect is greatest and the effect on the lamp filament is least when the circuit is established between both poles, while the former is least and the latter is greatest when one pole and the earth are used.

In "La Lum. Elec." Mr. Carvallo, under the head of "A New Law of Electro-magnetic Induction," gives some theoretical researches based on the works of Hertz and Maxwell. It is purely theoretical and belongs more properly under the head of physics. Among other things he deduces formulas which he claims to be more satisfactory than those given by Maxwell.

The article on an electrostatic motor abstracted in these columns last week is contained in full with illustrations in the Lond. "Elect. Rev.," Jan. 20, p. 79.

MEASUREMENTS.

A Selenium Photometer.—"La Lum. Elec.," Jan. 7, p. 29, gives an illustrated description of a photometer suggested by Mr. E. Thomas. A current is passed through a selenium cell in the form of a plate, and a galvanometer. This plate is revolved between the two sources of light to be compared and the currents sent through it commutated by means of a commutator operated by its shaft; when the illuminations from the two sources of light are equal the galvanometer shows zero deflection. Instead of revolving the plate it may be fixed and a mirror in front of it be revolved so as to reflect the light on it, alternately from one and the other lamp; or it may be placed behind a revolving screen with openings so as to screen off the light alternately from one or the other source.

In "La Lum. Elec.," Jan. 7, p. 21, Mr. Blondin gives the first part of an article entitled "Recent Researches in the Measurement of Temperature by Electric Means," in which he reviews the work done by a number of physicists in this field, giving special attention to those made by Mr. Callendar with an electric pyrometer. A great part of the paper is devoted to a discussion of temperatures rather than their electrical determination, the latter forming but a very small portion of the paper. He criticises the well known recent researches of Messrs. Dewar and Fleming, claiming that the temperatures they assumed were not correct. He gives the temperature coefficients of various metals, deduced from recent researches. A portion of the paper is devoted to a description of the Callendar pyrometer, for which it is claimed that an accuracy of 1-10 of 1 per cent. may be obtained up to 1,300 degrees C.

For measuring very high potentials by means of the sparking distance see above under electro-physics.

DYNAMOS, MOTORS AND TRANSFORMERS.

Coupling Alternators.—At a recent meeting of the Soc Int. des Electriciens, Mr. Blondel read a paper on "Coupling Alternators," the first part of which is given in full in "La Lum. Elec.," Jan. 7, p. 34. He treats the subject graphically by means of diagrams resembling the well known Zeuner diagrams for steam engines. The method, though interesting, is not very simple, and is intended only for those well posted on this subject. The

paper is of considerable length and is not of such a nature as to permit its being abstracted here, especially as he does not draw general conclusions. He divides the general theory into two heads; first, how can synchronism be established between two or more machines; second, how can they be kept in synchronism when one retards or advances in relation with the other.

He suggests the following method by which actions in the coupling of alternators may be studied experimentally. Two identical alternators have their shafts coupled through the medium of a torsion dynamometer, which may be so keyed that the two armatures differ in their relative positions by any desired angle. The mutual action between the two alternators may then be studied statically, that is, without permitting the armatures to revolve, and also dynamically. He also suggests that this method may be applied advantageously to studying the transmission of power by means of alternators, the power furnished them being in that case only that much which is lost in the transmission. He states, however, that this method is not always easy to carry out, and suggests his theoretical method as the more satisfactory.

Doubling the Frequency.—In the "Elek. Zeitschrift" Mr. Arnold makes some theoretical deductions regarding rotating coils in alternating fields, and arrives at the following conclusions: Suppose two coils placed at right angles to each other are caused to rotate in an alternating magnetic field; let w represent the speed of rotation of these coils; let W represent the speed of rotation of the magnetic field supposing it to rotate instead of simply alternating, that is, let it be the speed at which a continuous field would rotate in order to produce the same number of alternations with respect to a fixed point in the field. If w equals W, which means that the coils rotate synchronously with the alternations of the field, alternating currents will be induced in the coils the frequency of which will be double that of the field current, and the maximum electromotive force of which will be equal, but will differ by one quarter of a phase. The torque will in this case be zero for a complete revolution. If w is not equal to W the torque will no longer be zero, but will have a maximum value when the two are nearly equal, which maximum diminishes rapidly as their values change; when w is less than W the torque will be negative, that is, external work will be done. If w is greater than W the resulting torque will be positive, that is, external work will be consumed.

If these coils are not short circuited, but are provided with contact rings, two or more alternating currents of double the frequency can be led off. It follows from this that if two identical alternators are coupled mechanically, the first having its field excited by the alternating current of the second, then the first will generate an alternating current of double the frequency.

Transformers,—In discussing Dr. Fleming's recent paper on transformers (see the recent issues of THE ELECTRICAL WORLD), Prof. Perry remarked that two years ago he read a paper at the Royal Society, of which he gave the following abstract: In all calculations on transformers except one, namely, where they wanted to calculate the current supplied to an unloaded transformer, it made no difference whether they took into account hysteresis, eddy currents, and so on; the results were the same as if constant permeability were assumed. Assuming this, and no magnetic leakage or condensers or choking coils, everybody knew that the result was "the secondary current is the same as if it were produced in a circuit of resistance $R_1 (N_2 + N_1) + R_2 (N_1 + N_2)$ by the primary voltage V_1." Now, the simplest way of defining *magnetic leakage* was to say that a fraction of the induction due to the primary current escaped the secondary coil, and a fraction of the secondary escaped the primary. Let the sum of these fractions be called x. Evidently, then, the leakage produced the same effects as two little choking coils would, inserted in the primary and secondary circuits. Hence, R_1 and R_2 were no longer mere resistances, but contained self-inductions. In fact, "the secondary current is the same as if it were produced in an imaginary circuit of resistance $R_1 (N_2 + N_1) + R_2 (N_1 + N_2)$, and self-induction M x by the primary voltage V_1." This was quite an easy rule to remember. M was the mutual induction, or $M = N_1 N_2 \frac{\alpha \mu 4 \pi}{\lambda 10^9}$, where α = section of iron in square centimetres, μ = say, 2000, λ = average length of induction lines in iron. In a 1,500 watt Mordey transformer, M = 3.22, $R_1 = 27$ ohms, $N_1 = 460$ turns, $R_2 = .067 + \rho$, where ρ = external resistance of secondary, being 10 ohms at full load. The time constant s of a circuit mean its self-induction divided by its resistance, and here it is $3.22 x + (2.7 + 19.17 \rho)$. Its effect was to diminish the current 200 $s^2 \pi^2 f^2$ per cent. when not too large, and to produce a lag of 360 s f degrees. Here f was the frequency. Evidently the drop due to leakage was proportional to the square of the load. Taking x = .01, drop at full load in this Mordey is $5.567 \times 10 - {}^5 f^2$ per cent., and lag was 0.06 f degrees. He referred to a series of experiments made by Prof. Ayrton on the increased drop with greater frequency in Mordey and Swinburne transformers, and pointed out that the effect in the Swinburne was not necessarily greater, although x was greater, because in the Swinburne M was less, and it was the term M x which was important. The fundamental fact was that any induction for either coil which escaped the other was exactly as if they had a little choking coil in the first.

Transformers.—In discussing Dr. Fleming's paper Mr. Haycraft, in speaking of the current rushes and rises of pressure in transformers on switching them into circuit, describes some experiments he made and concludes that at a frequency of 144 there were practically no rushes of current except, of course, when sparks passed. His general conclusions were that current rushes in the primary were very frequent at low frequencies, while at 100 and above he could hardly detect them; also that the effect does penetrate to the secondary, producing considerable rises of pressure. Mr. Sparks remarked that the rush was most noticeable in a transformer in which the iron was worked at a high induction.

ARC AND INCANDESCENT LAMPS.

Electricity versus Gas.—Mr. A'Court, in a paper read before the Civil and Mechanical Engineers' Society (London), stated that in the London street lights three candles were obtained per cubic foot, while arc lamps of ten amperes and forty-five volts he claimed gave 1,500 c. p. at 45 degrees. A 10-ampere arc lamp complete with post and lantern costs about $90, while a complete 50-foot gas lamp, with post and lantern, costs about $70. The contract price for an all-night arc lamp in London and other towns was about $126, while that of a 50-foot gas lamp was $121, or about the same price for practically one-tenth of the light. For good lighting, he says that it has been found that 10-ampere lamps are required on both sides of the street, not more than 150 feet apart and at a height of 25 feet. For streets wider than 50 feet the lamps should be placed in the centre. Roughly speaking and making every allowance for gas, five 50-foot gas burners were required as against every 10-ampere lamp. On this basis the first cost for equal lighting is as 1 to 3.9, and the running expenses as 1 to 4.8, both in favor of electricity. For small streets gas light is cheaper than incandescent light of equal power.

Mr. Violle measured the temperature of the arc by placing a button of refractory material in the arc and, when heated, allowing it to drop into a calorimeter. He thus finds the temperature to be 3,500 degrees C. Mr. Vieille, on the other hand, by a mixture of explosive gases obtains a temperature of 4,500 degrees C., showing that by the latter method even a higher temperature can be produced than that of the arc. It is stated that the temperature of the arc remains constant no matter how much current is used, and that it is limited to the temperature of volatilization of carbon.

For a new and interesting form of arc light see under the heading Electro-Physics, above.

ELECTRIC RAILWAYS.

"La Lum. Elec." continues its profusely illustrated serial on electric railways, which appears to be a summary of patent specifications.

CENTRAL STATIONS.

Power Generators.—Prof. Unwin, in a lecture before the Society of Arts on the "Transmission of Power from Central Stations," stated that there was a tendency at present to give too much prominence to electricity, which undue prominence obscured the fact that there were other valuable methods of distributing power. In speaking of the Geneva hydraulic transmission and distribution he says the cost to the consumer was about $39 per horse power per year, or about 1.4 cents per horse power hour. The fundamental disadvantage of transforming heat into mechanical energy by means of the steam engine was that only about three-tenths of the original energy could by any possibility be turned into work. Internal fired gas engines had already given a thermal efficiency as heat engines equal to double that of large steam engines. The efficiency of gas engines for transforming heat into mechanical work was enormously superior to that of a small steam engine, but on the other hand they are more restricted in size than steam engines and work less economically at light loads.

From some charts which he had calculated from experiments he showed that at full load steam engines gave an indicated horse power at an expenditure of 1½ pounds for condensing engines and 1¾ pounds for non-condensing engines. The ordinary consumption in practice, however, was greater than on special experimental trials. Large pumping engines in London, working with steady load, which should require 2 pounds, used 2.7 pounds on a trial of many weeks. In central stations for electric lighting, where the load fluctuates very greatly, the results are far more unfavorable. Probably in very few cases were electric lighting stations working at 3½ pounds per horse power hour and in some cases double this. For small isolated engines results are far worse; in Birmingham, for instance, engines from 4 to 24 horse power were using from 8½ to 36 pounds per horse power hour.

In endeavoring to show where improvements could be looked for he stated that the mechanical efficiency of steam engines at full load was probably about .8 to .85 for small engines and might reach .9 for large ones. An engine giving 85 per cent. effective horse power and indicating 100 would have an efficiency of 70 per cent. at half load and 40 per cent. at quarter load. This shows that the great loss between the coal and the dynamo does not lie in the engine when running under full load, and he, therefore, traces the loss to the boilers, stating that by far the worse part of the want of good economy contained in central station lighting was due to the waste of heat in continually heating up the boilers and letting them cool down again; this waste due to a fluctuating load was inevitable if there was no means of storage. The problem of central stations, therefore, lies in seeking after means for storing energy. Gas engines have this advantage, as the gas may be stored. Taking the consumption of gas to be 25 cubic feet per horse power hour the cost of gas holders was $1.32 per horse power hour stored. The cost of gas holder storage based on the rate of supply and not on the capacity of the gas holders was $29 per horse power, which makes the charge for one horse power supplied continuously through the year about $2.40. What was required for electric lighting was a system of storage which would cover any possibility of fluctuation. He then mentioned the storage battery and compares it to the gas holder; the former is limited to a maximum rate of discharge, while in the latter this is unlimited; the efficiency of the former is 80 per cent., while that of the latter is practically 100 per cent. The best that had been done in practice was to use batteries having a capacity of one-tenth, or in small stations one-fifth, of the daily supply, which improves matters to some extent. He stated that the lowest cost of the batteries was $59 per horse power hour stored, against $1.32 for a gas holder, and $96 per horse power supplied, as against $29 for gas holders.

He then describes a new method suggested by Mr. Halpin, which Prof. Unwin believes will play an important part in the future. It is a method of storing heat by heated water under pressure. When the pressure was reduced, steam was generated instantly, and in absolutely determinable amounts, even explosively fast if reduced suddenly; it acted like the secondary battery, but was not limited to the rate of supply. In Mr. Halpin's method the heat, instead of being used at once, was communicated to a quantity of water in boilers, and the heated water was stored until the heat was wanted; it then gave it off in the quantity in which, and exactly when, it was required. The boiler pressure was 250 pounds absolute pressure, or 265 pounds atmospheric pressure, the temperature was 406 degrees, the steam engines are to be worked at 130 pounds, corresponding to 347 degrees. Whenever the temperature in the storage reservoirs was about 347 degrees, they would supply steam to the engines automatically at any rate required; 14¼ pounds of heated water in the reservoir will give one pound of steam; allowing for radiation and steam losses it will be, say, 16 pounds for one pound of steam at 130 pounds pressure. A simple cylindrical reservoir 8 feet in diameter and 30 feet long would contain 8,400 pounds of heated water, which at 406 degrees would deliver 5,250 pounds of steam at 130 pounds pressure. Allowing 18 pounds and 25 pounds for good condensing and non-condensing engines, one of these reservoirs would store 286 effective horse power hours with condensing and 210 with non-condensing engines. Prof. Unwin states that at present there appears to be nothing to hinder the use of heat stored in that way, the size of the boiler being by no means alarming in proportion. The total cost of one of these reservoirs, including accessories and building, is about $2,200, or about $8 per effective horse power hour based on the energy stored for a condensing engine, and about $11 for non-condensing engines. Comparing these with the figures for gasometers and storage batteries it is a good deal more expensive than the former, but considerably cheaper than the latter.

Prof. Unwin is a recognized authority on such subjects and his figures and indorsements, when they refer to mechanical and not electrical subjects, may, we think, be relied upon implicitly. As he indorses Mr. Halpin's plan, central stations may do well to give it careful consideration. We might add that the idea is not new, as it was suggested many years ago for operating locomotives without boilers for the London underground railroad; it is, therefore, not patentable.

Steam Turbine,—"La Lum. Elec.," Jan. 7, p. 31, gives a short illustrated description of a steam turbine devised by Mr. Edwards. The principle is similar to that of the well known Parsons turbine, but its construction differs. It consists essentially of a revolving disc placed between two fixed discs; all four of the adjacent surfaces are recessed with annular grooves fitting into one another, the alternate ridges between them being cut with diagonal apertures. The steam enters at the centre, passes through these apertures and out at the circumference; it imparts a rotary motion to the movable disc.

The "Zeitschrift fuer Elektrotechnik" (Vienna) of Jan. 15, gives a long and very full illustrated description of the new central station in Zurich. The description includes two large plates, one of the ground plan and the other of the circuits at the station. The station is run by water power and uses alternating currents. The elec-

trical machinery was constructed by Oerlikon; this station is doubtless one of their largest installations.

TELEGRAPHY AND TELEPHONY.

The curious phenomenon of the singing of a telephone described in these columns last week does not appear to be new, according to the Lond. "Elect. Rev.," which refers to a similar phenomenon noticed by Prof. Hughes and described in that journal of June 15, 1878, p. 255.

Electric Clocks.—"Electricite" in the issue of Jan. 12 begins a series of illustrated articles on electric clocks and their mechanism.

MISCELLANEOUS.

Sharpening Files by an Electrical Process.—The "Elek. Zeitschrift" states that the method of sharpening files, described some years ago, is meeting with great favor, especially in England and France, where it is used very largely. Baths are in use for treating 300 to 400 files at a time. One workman can attend to two such baths. Experience has shown that one man can in this way sharpen 400 files a day working 10 hours. The process can be repeated several times without injuring the files. This same method is also used to sharpen knives used in beet sugar factories. For this purpose it is said to give very good results and does not require any skilled labor, while at the same time it represents a considerable saving in the cost of sharpening knives.

(The method referred to is as follows: The dull and dirty files are first placed for 12 hours in a cold solution of caustic soda of 15 to 20 per cent.; they are then cleaned with a scratch brush and after another immersion are again cleaned with a scratch brush and a 5 to 6 per cent. soda solution. They are then placed in the following bath: Six parts nitric acid of 40 degrees; 3 parts of sulphuric acid; 100 parts of water. It is said to be very important to see that this bath is properly proportioned in order that the action is not too rapid. They are inserted in this bath, and connected to plates of carbon immersed close to them, by means of a copper plate connecting all the carbons and the files at the top. This produces a short-circuited battery which generates gas on the surface of the files. The gas formed creates bubbles which adhere to the points of the files, and protect them from being eaten away, while the rest of the file is being etched. They are taken out every five minutes and washed in water so as to remove the oxide which collects. They are then placed for half an hour in lime water made of one part by weight of slacked lime and 50 parts water; this is to remove the acid. They are then dried in sawdust and to prevent rusting are rubbed with a mixture of oil and turpentine. It is said that it requires but 20 to 30 minutes in the electrolytic bath to sharpen the files.)

The Edison Electric Illuminating Company of New York.—II.

The important development of the company occurred when it was decided, in 1887, that the success of the company justified its extension into the uptown districts. Property was purchased for the new stations in Twenty-sixth street and in Thirty-ninth street, and the work of erecting the stations was commenced in the summer of 1887. Simultaneously the new three-wire system of feeders and mains was laid underground. It was then the policy of the company to complete stations and equipment before beginning to deliver current, so that it was not until Thanksgiving Day, 1888, that current was delivered from the Thirty-ninth street station, and Christmas Day, 1888, from the Twenty-sixth street station, neither being fully under way until the first part of 1889. At the close of 1888 the company had on its records 710 customers and 16,377 incandescent lights. The first motor had been put on the system in the downtown district in the fall of 1884, and the first low-tension arc light had been connected with the system uptown in the spring of 1889.

The new station, extending from Duane to Pearl street, next Elm, is noteworthy for providing a capacity of nearly 30,000 h. p. (the equivalent of 300,000 16 c. p. lamps burning at once, or over 400,000 installed) upon ground 74 feet by about 200. The central idea has been to replace land engineering practices by marine engineering methods.

The main floor is 30 feet high from floor to ceiling, with 10 feet space beneath the floor for engine foundations, condensers, piping, cables, etc., and it is intended to contain ten 2,500 h. p. engines, each with a pair of 800 k. w. dynamos; two 1,250 h. p. engines, each with a pair of 400 k. w. dynamos, and two 600 h. p. engines, each with a pair of 200 k. w. dynamos. In the centre of the eastern side wall will be the electrical gallery for the control of the feeders and of the dynamos, with voltmeters and ampere meters so large that they can be seen across the station, and a glassed gallery at the Pearl street end affords the station superintendent a view over the whole room. Above the main floor is a second floor for shops and stores, with a space of 10 feet wide divided off on each side for the steam pipes, and for collecting the hot air of the engine room to be sent to the stacks and there superheated for the boiler furnaces. The third floor is for the blowers, pumps, ash conveyers, air ducts, etc., beneath the boilers. The fourth floor, following the practice originated in the uptown stations, is the boiler room, providing for thirty separate boilers ranged on both sides, with a central passage way for firing. The boilers will be of steel, on the safety water tube principle, for at least 200 lbs. working pressure, extra long and extra high, with proportionately extended grate area to obtain the greatest steaming power from the least possible floor space, and they will develop steam for 20,000 h. p. (of multi-expansion engines at 15 lbs. per horse power), and with forced draught for 30,000 h. p. The fifth floor provides for the coal bunkers, approximating 3,000 tons capacity, under whose sloping sides will be the main smoke flues with feed-water economizers, and above these water storage tanks. Continuous coal conveyers will bring coal from two hoppers at each street front, for use alternately for receiving and weighing the coal and for discharging into the conveyers, and these, after emptying the coal into the bunkers, will return under the boilers, carrying the ashes down—arrangements being made that the carts which bring the coal shall take a load of ashes to the dump on the return trip. The office floor will be above the coal bunkers, reached by elevators and stairways from each front, and from the eastern wall will rise the two huge smokestacks of brick and steel, so arranged that the hot gases will be utilized to heat the air furnishing the draught for the boilers. The plans for forced draught and for utilizing the hot air can be thrown out of service at a moment's notice, and the whole system is so arranged as to be interconvertible, and to permit of promptly throwing out of use for repair. The whole system will run at the highest economy during ordinary loads, while for the hour or two of maximum load, or in emergencies, the whole or any part can be forced 50 per cent. or more above rated capacity, thus saving the investment of so much additional capital. These features of the building are shown in the sectional plan, Fig. 1.

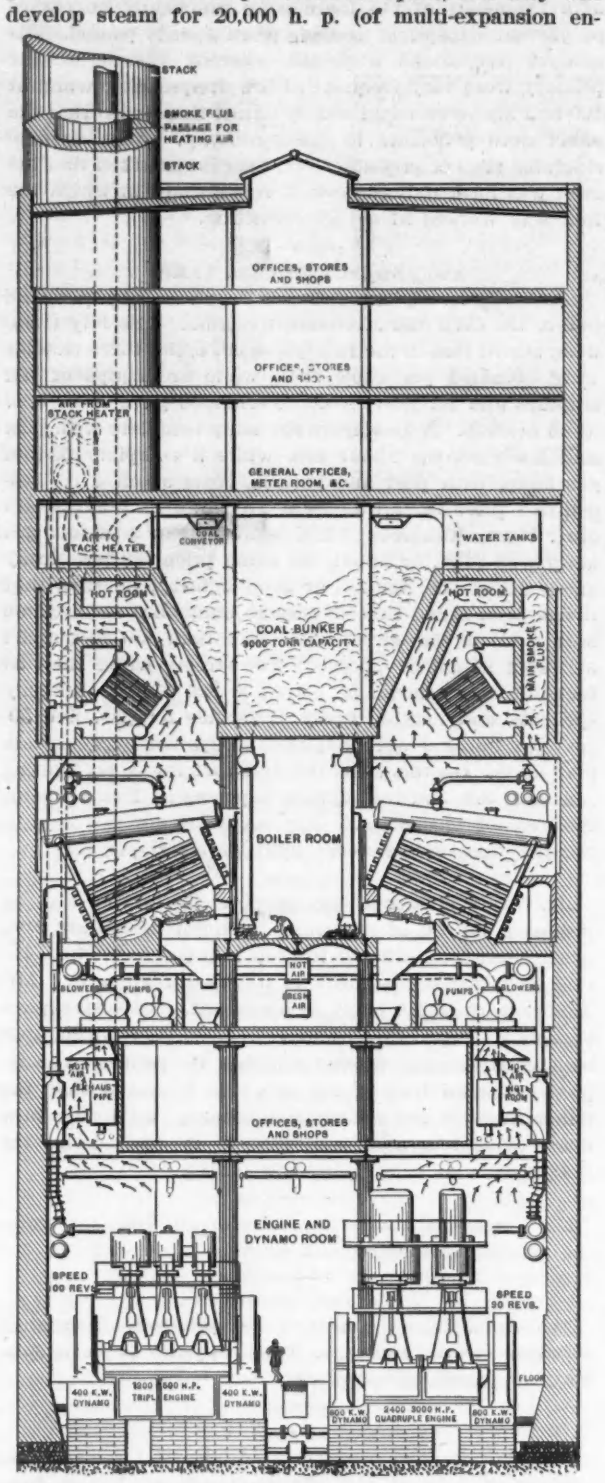


FIG. 1.—SECTIONAL VIEW OF NEW EDISON STATION.

The general plan of the new station will be of the 2,500-h. p. engines, of which there will be room for ten. The first of these is now being manufactured by the Dickson Manufacturing Company. The arrangement of the engines is shown in Fig. 2.

The dynamos provided for the new engines are all of the new multipolar type direct driven from the engine shaft, avoiding belting, and are of the external yoke or Gramme type, which for some years has been a favorite in European practice. Their improvement on the European type, in having no separate commutator or "outboard" bearing, effects a considerable saving in floor space.

All the dynamos in the new station will be controlled from an electrical gallery placed against the supports for the smokestacks, near the centre of the engine room, a few steps above its floor. The main feeder-controlling switchboard will be at the back of this gallery and will be constructed for operating 75 feeders within a length of 40 feet, including a doorway through the centre. The mechanism for each feeder will have 1,500 ampere capacity, and each entire feeder unit, including the main resistance switches, the ampere meters and the pressure indicators, will take up a space only three inches wide—a concentration of electrical apparatus hitherto unapproached. Back of this switchboard will be the feeder resistances, each feeder having three, which can be inserted in circuit for feeder regulation. At the front of the electrical gallery will be placed the dynamo-controlling apparatus, with a main ampere meter having a capacity for 100,000 amperes on each side, probably on the same principle as the ampere meters of 30,000 ampere capacity on each side now being built at the works of James White & Co., Glasgow, for the Twenty-sixth street station. The main voltmeters, also under construction there, will be two feet in diameter, so that the pressure can be noted from any part of the room.

The old Pearl street station and the Produce Exchange annex downtown, and the Thirty-ninth street station annex uptown, remain with the same electrical capacity as heretofore. The new central station downtown has a capacity of 26,950 amperes, which will be increased to 38,550 amperes within a month. The Twenty-sixth street station has a capacity of 16,200 amperes, which will be increased to 19,100 amperes early in the year; the new Fifty-third street annex has, with generating units and storage battery, a capacity of 1,800 amperes for the hour.

The general use of storage batteries in connection with station work in England, France and Germany made it seem advisable to experiment with a storage battery of a type in successful operation in England, which would not be complicated with the legal questions involved in the storage batteries hitherto known in this country. Arrangements were therefore made with the Crompton-Howell Storage Battery Company, Limited, of London, to instal in a portion of the new Fifty-third street station, arranged for that purpose, a storage battery of 2,000 ampere-hours capacity, on which guaranties of 85 per cent. efficiency in ampere output and other guaranties were obtained. This battery is now installed at that station and will presently be working as a part of the operating system.

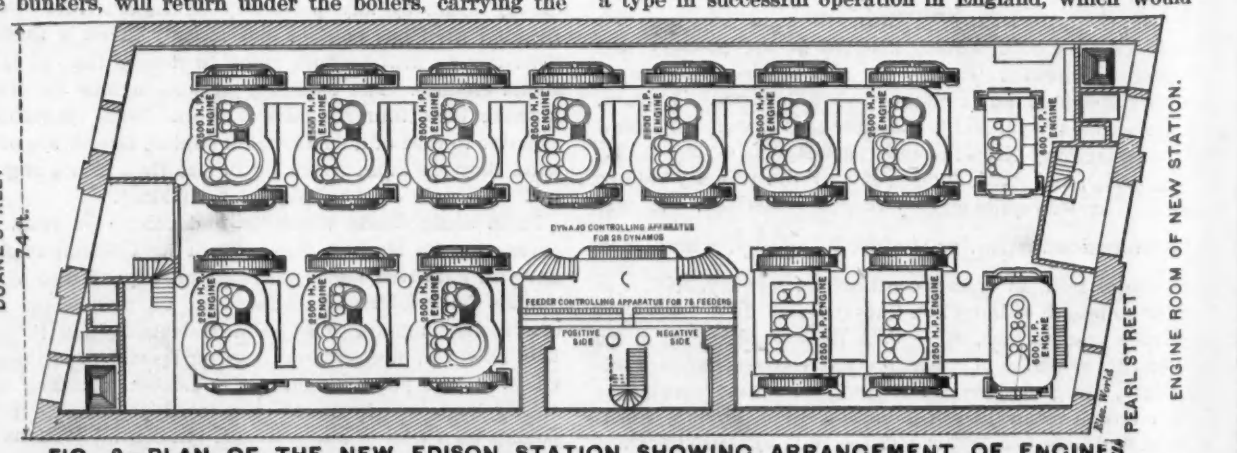


FIG. 2.—PLAN OF THE NEW EDISON STATION SHOWING ARRANGEMENT OF ENGINES.

The Electric Gas Lighting Company's Establishment.

Electricity, in its rapid stride, has to-day reached that point where it has come to be regarded as the most desirable producer of light and power. With its rapid advancement it has been a powerful revolutionizer of old customs, and where it has not entirely replaced the best light producer the world before ever knew, namely, gas, it has claimed a partnership with it, so to speak, in the shape of electric gas lighters.

The application of electricity to gas lighting is to-day very general, and the demand for gas lighting appliances has made it necessary for manufacturers, seeking this particular trade, to give almost their sole attention to its demands.

The Electric Gas Lighting Company was among the first to foresee the great prospects in this line of trade. It was incorporated in 1882. Since that date it has, under the efficient managership of Mr. Louis W. Burnham, extended and expanded, till its trade now is almost world wide. To keep in line with this advancement it has found it necessary to seek a new location for its factory, where it would have ample room to enlarge as the business grew. This it has found in the new works, located at 240 Dover street, Boston.

The floor space comprises about 6,000 square feet, and it is in every sense a modern workshop, under the superintendence of Mr. Thos. W. Lane, assisted by Mr. Geo. Galbraith as foreman.

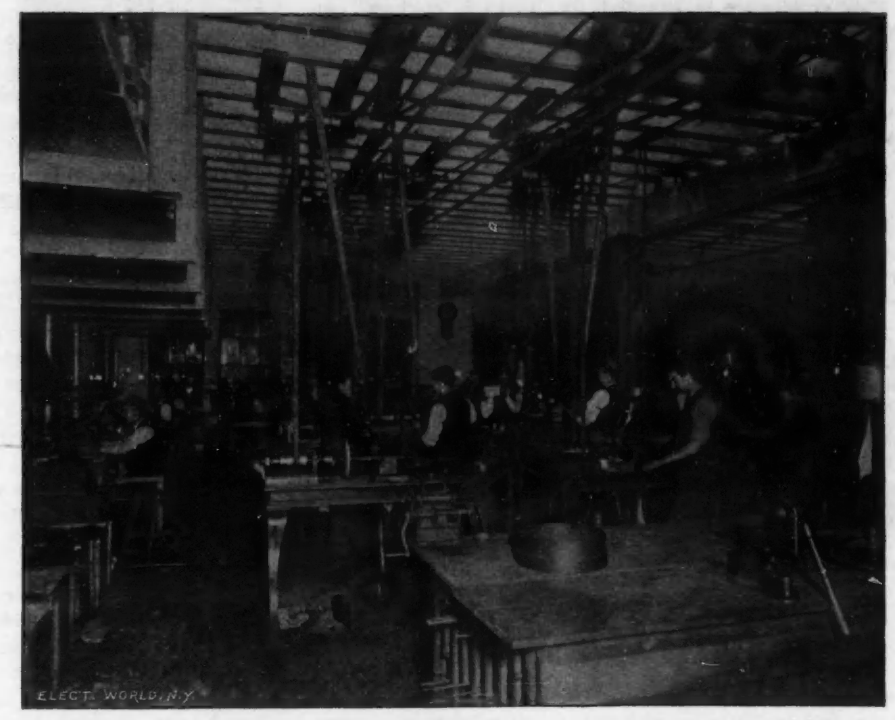
As one enters, he comes immediately into the office. Entering the works, and moving to the northeast, he comes into view of the stockroom, and here will be found material of various kinds, all assorted. Passing down in the same direction will be seen the buffing room, and next to this will be found the plating rooms and the Samson battery zinc quarters, departments which requires the constant employment of four to six men.

From this department, and extending to the northwest side of the building, are located the various machines, including spindle drills, punch presses, milling machines, screw machines, lathes, grinding machines, etc.

Located in the front of the building are the assembling rooms, where the numerous burner parts are brought and put together. In this department many skilled workmen are employed, and the careful and expert manner in which they do their work is quite apparent to the observer.

Going from this department again toward the entrance will be seen the bell and cut-out department, the annunciator, wood-working, lettering and special departments, which are located in the centre of the works. Glancing at the walls, it will be seen that a shelf extends the whole length of the spacious room, and on this shelf, some five feet wide, packed in their proper rows, are various styles of annunciator and cut-out cases. On the opposite side another shelf of mammoth size will be seen. This contains manufactured goods, assorted, done up and ready for immediate shipment.

In all, it will be at once apparent that this is one of the best equipped works devoted to gas-lighting appliances, annunciators, electric bells and general electrical supplies in the United States, and the Electric Gas Lighting Company deserves the success which its persistent efforts have won.



INTERIOR VIEWS OF THE ELECTRIC GAS LIGHTING COMPANY'S ESTABLISHMENT.

The White & Middleton Gas Engine.

This gas engine, the invention of Charles White and A. R. Middleton, is manufactured by the White & Middleton Gas Engine Company, East Falls avenue and Pratt street, Baltimore, Md. Practical tests have shown that this engine not only very economical, but it runs with remarkable smoothness.

It is of the compression type of gas engine, the piston is of the trunk pattern connected to the crank direct by the wristpin and connecting rod without a cross head. The method of its working is similar to that in other familiar types and is as follows: The gas and air which are mixed in the chamber are drawn through the valve opening into the cylinder by the outstroke of the piston and compressed in about the proportion of four to one by the following instroke, and ignited on the centre by uncovering the inlet to an incandescent closed tube, the charge being exploded and the impulse received on the outstroke. The exhaust port is uncovered by the piston at its extreme outstroke, and the products of combustion, or upward of three-fourths of it, are discharged. The balance of the burned charge remaining in the cylinder at atmospheric pressure, except that filling the explosion chamber, is expelled through the valves by the following instroke, and a fresh charge of mixture taken in by the next outstroke.

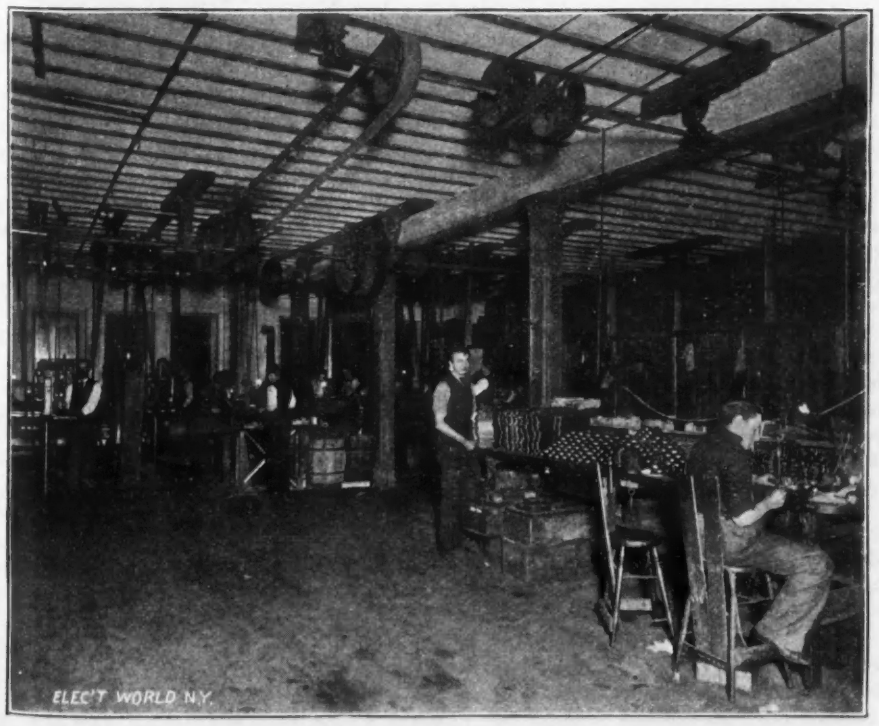
The construction of the governor is novel, neat, and very effective, giving a close regulation. The incandescent closed tube igniter works with positive and prompt ignition without the loss of a single charge, even under a speed of 280 revolutions per minute. The tube is a one-fourth inch gas pipe, nine inches long, closed at the top and screwed into the cylinder, being kept red hot by a Bunsen burner surrounding it.

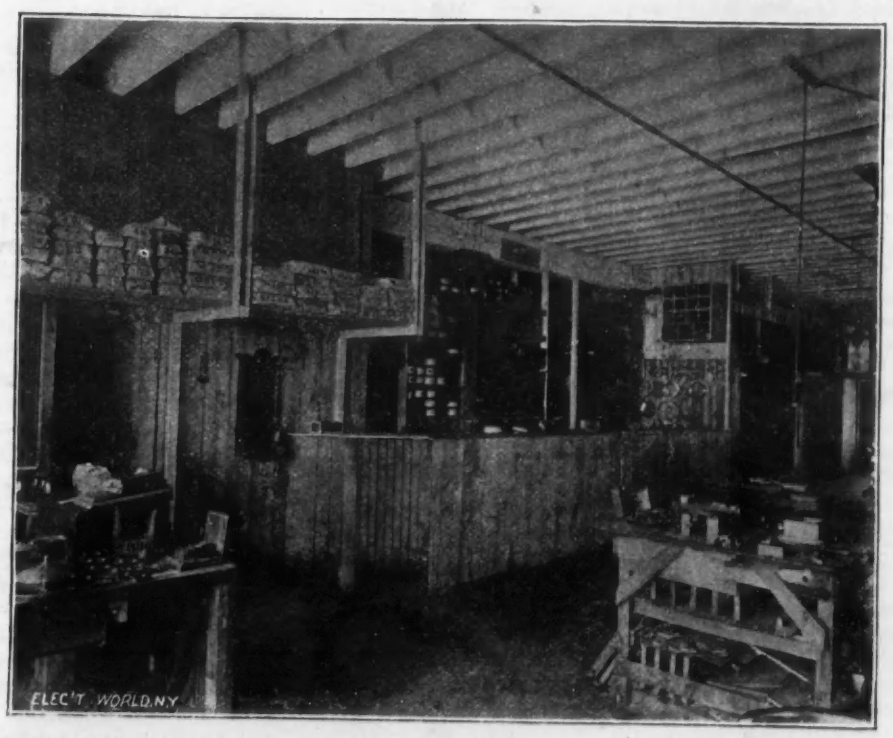
This engine has been tested on several occasions at the American Institute Fair, and the following is an extract from the judges' report on one of these tests: "Duration of test, 10 minutes; average speed, 215 revolutions per minute; actual brake horse power developed, 5.98; consumption of gas during 10 minutes, 19 cubic feet; consumption of gas per brake horse power, 19.06 cubic feet." Other tests of longer duration give even better results and show a consumption of 16.02 cubic feet of gas per brake horse power per hour. The company guarantees its engine not to consume more than 15 cubic feet of gas per hour per indicated horse power with gas of equal quality to that furnished in Baltimore, Md. The simplicity of construction, durability economy and noiseless running of these engines are points which will undoubtedly lead to their extended use.

The Buffalo Single Cylinder Independent Air Pump and Jet Condenser.

The application of the air pump and condenser to high pressure or non-condensing engines is equivalent to a material increase in power and a considerable saving of fuel, or to a corresponding reduction in boiler pressure. The air pump and condenser shown in the accompanying illustration is manufactured by the Buffalo Steam Pump Company, of Buffalo, N. Y., and contains all the qualities suggested by long experience and modern practice. They are manufactured in various sizes up to that intended for use with an 1,800 h. p. engine.

The injection water required to maintain a vacuum of



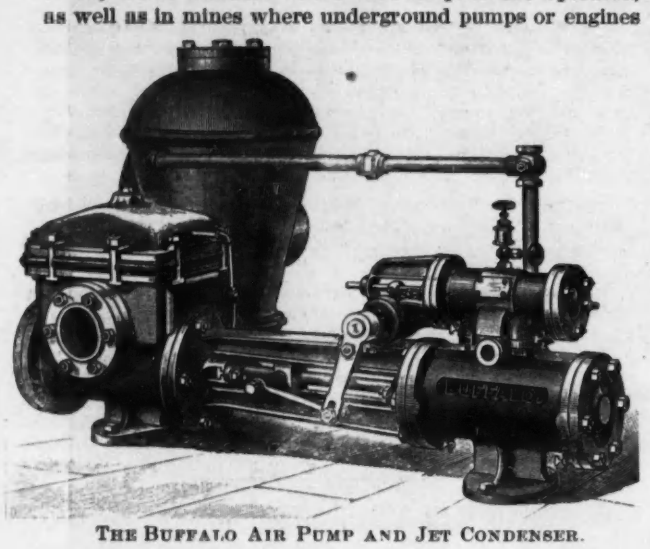


INTERIOR VIEWS OF THE ELECTRIC GAS LIGHTING COMPANY'S ESTABLISHMENT.

from 24 in. to 27 in. in the condenser will be about 20 to 25 times the amount evaporated in the boiler and used by the engine. The hot water from the discharge can by means of the feed pump be returned to the boiler at about 100°, or at a very much higher temperature if a heater be used.

A single condenser can be used with two or more pumps or engines, one or all of which may be stopped without interfering with the action of the condenser.

This condenser is adapted for marine engines employed in bay, lake or river navigation. It is also fitted for use in connection with vacuum pans, either single, double or triple effect, in sugar refineries, or for service in any other business where vacuum pans are operated, as well as in mines where underground pumps or engines



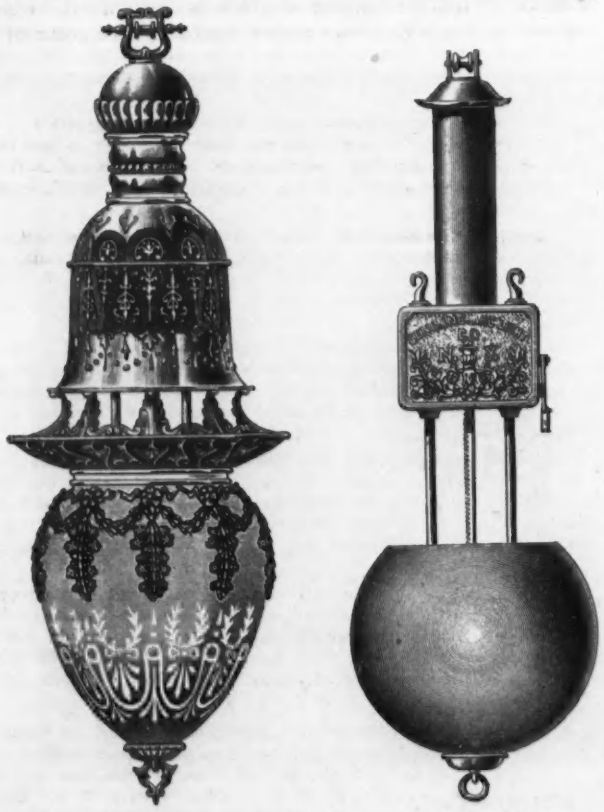
THE BUFFALO AIR PUMP AND JET CONDENSER.

are used and where exhaust steam is objectionable. When required it may be used as an independent bilge pump. Having no direct connection with the engine except the exhaust pipe it can be started before the main engine, freeing the cylinder from water and forming a vacuum in the condenser. The condenser being independent the power consumed by its operation is not an additional load for the engine. It is self-contained and no expensive foundation is necessary. It lifts its own injection water and will maintain a high and steady vacuum no matter how variable the load on the engine may be. The condenser is so constructed that the distribution of the injection water is uniform throughout, giving complete condensation of steam with the least amount of water.

The condenser is also arranged with an automatic attachment so that if through any unforeseen accident the air pump fails to act the vacuum is destroyed, the inflow of the injection water stopped, and the flooding of the engine cylinders prevented. The linings of pump cylinder, pump piston, valve seats, etc., are all made of the best gun metal composition, and all piston rods and valve bolts of Tobin bronze. The arrangement of the suction valves in this pump insures a uniform and almost perfect vacuum.

The General Incandescent Arc Light Company's New Lamps.

Considering the many advantages which the arc light possesses in certain directions over the incandescent lamp,



GENERAL INCANDESCENT ARC LIGHT COMPANY'S LAMPS.

it is perhaps a little strange that the arc lamp is not more universally used at the present day on incandescent circuits. They are, however, steadily gaining in favor and coming into more general use. The chief reason why they have not been adopted in more instances is that the ordinary arc lamp does not possess the steadiness of illumination characteristic of the incandescent light, and also in a system of arc lights the illuminating power is less flexbile and cannot be varied within such wide limits. Furthermore, the arc lamps have not been, as a general rule, of ornamental appearance, and therefore not very well suited for interior use.

The General Incandescent Arc Light Company, of New York, has just brought out a series of new lamps which are designed to overcome these objections and to be especially adapted for interior and decorative work. The most interesting feature of the lamp is the simplicity of its mechanism, which consists of but one magnet and three wheels, with a single spring and without a dash pot. The upper carbon has a simple universal joint, which permits the carbon to be lined up perfectly true under all circumstances. The lower carbon holder consists of a slotted screw which automatically clutches the carbon when the holder is screwed home in the bottom of the lamp. This makes it possible to trim the lamp without removing the globe, which entirely prevents globe breakage. Both the upper and lower carbon holders are designed to take any sized carbon.

While the standard lamps are made to run two in series, one of the important features of this new type of lamp is that they can—in sizes up to six ampères at present—be placed three in series on a 110-volt circuit, or six in series, across the outside wires of the three-wire system. In a recent test which we witnessed, the three lamps thus arranged burned with remarkable steadiness and the distribution of light was better than could be obtained by the use of two lamps only. Not only is there a gain in the distribution of light, but when three lamps are used there is much less waste in dead resistance. Thus, with the ordinary 110 volt circuit with two arc lamps in series, each operating at about 43 volts, there will be 86 volts consumed in the lamps proper and 24 in resistance; while with three lamps in series, each taking 35 volts, there will be 105 volts usefully employed and only five lost in resistance. For interior work especially it is necessary to be able to vary the illuminating power of the lamp. In these lamps it is possible to vary the potential from 100 to 120 volts, thus widely varying the candle power, without causing the lamp to flicker or injuring its lighting power in any way.

Another interesting feature of the General Incandescent Arc Light Company's lamps is that they may be run with any current from 3 to 20 ampères with the consequent range of candle power without a single adjustment of the lamp mechanism proper, and with only a change in the size of the carbons and a variation of an external resistance connected in series with the lamp. In the rack rod lamp the resistance is attached to the lamp itself and is insulated by porcelain insulators; an external resistance has also been designed consisting of German silver wire wound on porcelain saddles and making a fire and moisture proof construction.

Various styles of these lamps from the ordinary plain type to the most ornamental have been designed by this company, two of which are shown in the accompanying illustrations. The lamp designed to burn 12 watts is 42 inches in length and weighs only 18 pounds, and operating three in series at six ampères gives between 700 and 800 c. p. The 8 and 10 ampère lamps, operated two in series, give respectively 1,000 and 1,300 c. p. For use with low ceilings and especially for interior work, a small ribbon lamp has been designed which is called the "Bijou." This is admirably adapted for the illumination of even the smallest rooms, and its candle power can be varied from 150 c. p. up. It is very small in size and artistic in appearance and burns with great steadiness.

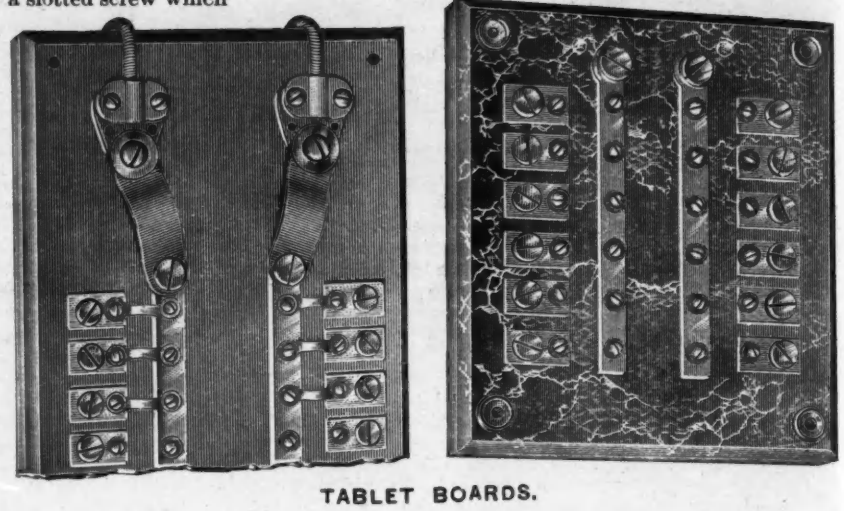
The General Incandescent Arc Light Company, of which Mr. S. Bergmann is the president, has its offices at the corner of Duane and Elm streets, with showrooms at No. 275 Fifth avenue. The works of the company occupy a large building, which it owns, on the corner of Thirty-third street and First avenue, New York City, where the smallest details of the lamps are manufactured.

Tablet Boards.

This device, as shown in the accompanying cuts, is designed to take the place of branch cut-outs, and form a centre of distribution for the numerous branch circuits necessary for house and theatre wiring, and other work of like character.

The idea is to provide a cut-out to which the service mains may be attached, and the smaller or distributing circuits brought together and receive current through an entirely separate fuse of required capacity; thus all distributing circuits receive their current from one set of mains.

This does away with the annoyance of having branch blocks located in various places throughout the building. A simple inspection of this cut-out will reveal its simplicity of construction, and it will be readily seen that, should any circuit become damaged, it will in no way affect any of the others.



TABLET BOARDS.

The boards are made of any number of circuits, the brasses shown in the cut being the standard for regular work; however, almost an endless variety of special boards are being made, with extra heavy lugs, either with solder or mechanical connections, for very heavy currents.

The connections are so arranged that the wires may either enter at the back of base, or at the top or side. The brasses are cast with heavy bases, and are securely set in the baseboard and fastened by screws from the back, the screw holes being countersunk and the space filled with insulating material, thereby obviating any possibility of escape of current by dampness.

Extra fuse connections are also made when desired, as shown in the cut. The connections now being used are of a handsomer and more convenient design than those here shown.

All the material used is of the best. The bases are made of slate finished in various ways, and in also Italian and Tennessee marble, all metal work being of new brass, polished and lacquered.

The manufacture of this style of cut-out or "tablet board" is made a specialty of by Messrs. J. L. Hays & Co., 830 Liberty avenue, Pittsburgh, Pa.

A New Call Bell—The Unique.

The Viaduct Manufacturing Company are constantly adding to their already long list new styles of district telegraph instruments, call bells, etc., as the public are made aware by their announcements from time to time. During their long experience in this line, they have pushed their wares into nearly every town and village of this country. One of their latest instruments is that herewith illustrated, which is a portable call bell intended for use in offices, sick rooms and in other situations where for any reason it is not desirable to place permanent wires. This instrument consists of a neatly varnished black walnut case, 3½ inches square by 8 inches high, provided with a leather strap handle by which to carry it in the hand. Within the case is located a single cell of dry battery and on the outside a neatly constructed electrical bell.

A NEW CALL BELL.

Leading from the bell and battery is a long flexible conducting cord terminating in a convenient split wooden handle forming the two terminals of the electric circuit. This circuit is normally broken, but by gentle pressure of the hand the two parts of the handle are brought into electrical contact and the bell rings. This instrument is especially adapted to sick rooms, or in other temporary applications, the handle being placed within easy reach of the patient or other person requiring assistance, and being self-contained may be introduced or removed at a moment's notice.

The Chicago & St. Louis Electric Railroad Awards the Contract for the Construction of Its Whole Line.

The Chicago & St. Louis Electric Railroad has closed the contract for the entire roadbed, including grading, bridgework and track-laying, exclusive of the electrical plant and the 26 miles of grading which was let last October and is now approaching completion. The contractors are Bagnall Brothers, of St. Louis, and Givens Brothers, of Memphis, Tenn. Both of these firms are well known and have laid more than 1,800 miles of railroad track for various Western and Southern roads. The contract price is $5,500,000, of which $2,750,000 is to be taken in bonds of the company at par. The time limit of the contract is one year, but it is thought probable that by fall the roadbed will be completed, as it is proposed to start work immediately at several different points and work in both directions.

This would seem to indicate that it is the intention of the company to push the construction of the road through as rapidly as possible. It is also reported that a portion of the road will be operated as soon as completed.

Financial Intelligence.

THE ELECTRICAL STOCK MARKET.

[Inquiries from our patrons for information relative to stocks and bonds of the various electric light and power companies are solicited, and will be answered in this column.]

NEW YORK, Feb. 4, 1893.

NEW YORK GENERAL FINANCIAL STOCK MARKET.

The market of the week, after a variety of ups and downs in the various specialties, closed strong in the face of gold exports, a decrease of nearly four and one-half million dollars in the surplus reserves and the probability that there will be heavy exports the coming weeks of the month. The monetary situation is most alarming, owing to the fact that the Treasury gold reserve is rapidly reaching the minimum, and that it is now lower than it has been at any time since the resumption of specie payment. To aggravate the situation, Austria and the Bank of France are now paying the premium on gold which they find necessary in order to obtain their supply from the United States. Notwithstanding this condition, money rates are nominal. The flow of currency from the interior has caused an accumulation in the trade centres. Money markets throughout the West and Northwest are generally easier. The state of trade is less satisfactory than at the time of our last report. There has been a depreciation in the prices of many staples. Irons, grains, lard, cotton, raw sugar, high wine, petroleum and hogs are all lower. There has been some advance in all grades of wool. leather, hides, rubber goods and shoes. Bank clearings in January were nearly 12 per cent. larger than in the previous year. The railroad movement shows a great increase in tonnage. Failures for the week numbered 255, as compared with 273 for the same week last year. The demand for textile fabrics continues. The market for cottons is said to be better than for 20 years.

In the financial stock and bond markets prices have, on the whole, appreciated during the week, after a decided bull movement Monday and Tuesday. Distillers opened the week at 41, after closing at 49 on the Saturday preceding, from whence it sold rapidly down to 34. This radical slump, which might be said to have started from 72—the ruling quotation six weeks ago—was due to the collapse of a large bull pool formed to elevate the stock. This gave rise to a variety of conditions, all of a bearish nature, and culminated in the quotation of 34. This movement of course intimidated the general public and narrowed the market, especially in the industrials. During the first two days of the week it looked as if a general decline was in order. However, various stocks were given an extra support by their backers, and the movement resolved itself into one of a bullish nature. On Friday it was whispered about the Street that the differences in the Distillers crowd had been settled and that the stock was in for an advance. This lent a tone to the market, which resulted in a firm close. Judging from present conditions, the market of next week will possess more or less buoyancy. However, conservative houses are of the belief that no very pronounced bull movement can gain headway so long as our financial condition is so menacing. This feeling is widespread, and has created a mincing, uncertain, temporary market, in which operators so place themselves that they can run at a moment's notice. This, of course, keeps the general public away, and also discourages buying for long time investment. It can be said with truth that the electrical stocks are regarded with a high degree of favor by people who are looking for what they consider staple quotations, and we would not be surprised to note additional attention toward this line of securities before the summer has run its course.

NEW YORK GENERAL ELECTRIC STOCK MARKET.

The market of the past week was a very satisfactory one to the holders of electrical securities. We note an advance in the values of nearly all the active stocks; general inquiry was reflected in bids and an absence of speculation. The feature of the week was the advance in the bonds and stocks in the Edison Electric Illuminating Company, of New York, which will be treated elsewhere. Of the inactive stocks, North American closed at 11⅛ to 11¼. The Interior Conduit and Insulation dropped to a state of innocuous desuetude. It did not receive a bid, much less a sale. However, this is not considered as detrimental to the property, as there was no pressure of the stock on the market. Judging from the strength at the close of the general market and the intimate relations which this list of specialties bears thereto, we are inclined to the belief that next week will be a good one for the more active electrical stocks. This in turn will draw attention to those of the less active character, all of which will aid in building up a market in this line of specialties, which has so long been prophesied, and which will some day surely materialize.

Western Union.—This stock showed firmer tendencies this week than last. The range of fluctuation was narrower and the trading less in volume. This gives rise to the belief that it was neglected by room traders and professional operators, the transactions being more of an investment and realizing nature. The closing was strong at 98⅜ bid and 98⅝ asked. It has been the history of this stock during the past few weeks that it has been quiet when Manhattan was active, and active when Manhattan was quite. This of course is attributable to the controlling interests in each of these properties, which are the same. Activity in one draws attention from the other. It is worthy of note that each stock is rendered strong support. This in turn is establishing a confidence on the part of the public in Western Union, which will take some time to thoroughly crystalize, but which at the present time is much greater than that which existed under the Jay régime.

General Electric.—This stock closed the week at the highest quotation, namely, 111¼ bid and 111½ asked. The lowest point reached during the week was 110½. The stock was traded in only a limited way and up to Friday showed a decided tendency toward a decline. The cause of this weakness is undoubtedly the unfavorable decision of the Boston Court regarding the incandescent lamp. Viewed broadly, it has not affected the stock materially, beyond keeping it at the minimum quotation of the past six months. Regarding this case the following points are made: The argument of the case of the Edison Electric Light Company against the Beacon Lamp Company, involving the Goebel lamp, was closed before Judge Colt in Boston Feb. 2. The defendant submitted 24 affidavits in addition to the 30 already filed, tending to show the invalidity of the Edison patent because of the Goebel use. The Edison lawyers vigorously opposed this application, but the judge finally admitted all the new papers. General Electric people are reported somewhat less confident than heretofore in regard to the right of the Westinghouse people to use their new lamp. The company's counsel are said to have given their opinion some time ago that a lamp made in two parts would not be an infringement of the Edison patent. The Edison patent is on a combination of a carbon filament in a vacuum. The Westinghouse people feel such confidence in their position that they have extended an invitation to their competitors to inspect the new lamp in operation. The bonds were in very good demand at the established quotation of par and ⅛ to ¾.

Edison Electric Illuminating of New York.—This stock showed phenomenal strength throughout the week, closing to-day at 131, the highest point ever reached. Those readers of THE ELECTRICAL WORLD who have followed our reports upon the operations of this company and its financial exhibits have been fully notified of this pronounced appreciation in the stock's value. The jump to 131 to-day is an increase of five points over the last quotation of Friday. The advance to-day was due to the demand of the several brokers who appeared simultaneously on the floor of the Exchange with orders to buy the stock at the market. There was none available at ruling quotations, consequently they bid up the price. The bonds scored an advance to 126, in sympathy with the stock. The buying has been largely for investment; toward the close it was accelerated by the action of home traders, who saw that the stock had strong support from parties who were regarded as insiders and would not be apt to throw it upon the market in order to realize on a point advance. The transactions in the first five per cent. bonds were the largest in several weeks, the price being advanced to 126 on sales of $160,000.

American Telegraph and Cable.—This stock closed the week at 92, a net gain of one point. When it was selling around 85 to 87 we stated that it was worth about as much as Western Union; that it would either approach Western Union, or that Western Union would approach it. The new and conservative element which has acquired so heavy an interest in Western Union of recent date has practically insured for that stock a quotation in the 90s. Consequently the appreciation of the Telegraph and Cable stock, as noted, was expected.

American District Telegraph.—This stock showed an advance toward the close of the week, upon the action of the company in increasing its tolls 33 per cent. There will be very little increase in the operation of the company in consequence, and probably little falling off in the volume of business; consequently we can assume that nearly all of this per cent. will be net. If the company succeeds in maintaining its new schedule without creating opposition, its stock will have an earning capacity which will entitle it to a place above par. The company evidently proposes to use to the fullest extent the monopoly which it has in the business in New York City. THE ELECTRICAL WORLD recently noted the decision of the company to charge 50 cents per month rent for call boxes. Official notice was given this week that the tolls for messenger service will be increased 33⅓ per cent. The tariff heretofore has been 30 cents an hour. The new schedule makes it 40. The minimum rate of 12 cents a message has been raised to 15. Mr. Tinker, an officer of the company, says, in regard to this move: "Only severe competition caused us to ask such low prices. Now that this has been eliminated by the absorption of the Mutual District Telegraph Company, we are determined to ask a just remuneration. For this reason, a monthly tax of 50 cents for each call box and this increase in rates were instituted." The company also claims its right to reduce its liability for loss or damage from $100 to $25.

Westinghouse.—Westinghouse earnings for the current fiscal year, it is said, will be above 14 per cent. on the stock, and it is anticipated that the common stockholders will get a dividend in July. One lot of the E. & M. assenting certificates sold at 74¼, or 37⅛ for a half share. The company paid into the State Treasury of Pennsylvania Feb. 2 over $50,000 as the outcome of recent tax suits with the commonwealth.

Closing Quotations.—The following were the closing quotations of electric stocks on Saturday, Feb. 4, 1893, and the range for the week in New York:

NEW YORK QUOTATIONS.

	Par.	Capital outstanding.	Lowest.	Highest.	Bid.	Ask'd.
American District Tel....	100	3,825,000	57	59	58	59
American Tel. & Cable..	100	14,060,000	91	92	91	92
Central & So. Am. Tel....	100	6,500,000	....	....	110	117
Commercial Cables.....	100	7,716,000	....	....	170	185
Gold Stock & Tel	100	5,000,000	.	....	100	103
Bonds.....	500	500,000	....	....	...	....
Franklin.....	100	1,000,000	....	....	35	40
Mexican Telegraph.....		2,000,000	....	....	180	200
Northwestern Telegraph.		2.500,000	....	....	102	105
Northwestern Tel. 7's.		.....	....	....	108½	....
Postal Tel. & Cable..... ...		10,000,000	...	....	81½	82½
Southern & Atlantic Tel .	25	948,775	....	....	78	83
Western Union Tel.....	100	94,820,000	97¼	99	98⅜	98⅝
Real estate bonds.. ..	1,000	1,219,000	....	....	....	....
Debenture 7's.....	1,000	4,920,000	113	113	105¾	106
Collateral Trust 5's....	1,000	8,181,000	105¾	105¾	...	...
North American.....	100	39,767,200	10⅞	11¼	11	11½
Brush Ill. Co. of N.	50	1,000,000	....	....	25	30
Edison El. Il. of N. Y.....	100	6,100,000	124½	131	131	131¼
" " Ists	...	... .	120	126	...	126⅝
" " Deb's.... ...		....	....	....	...	....
Edison El Il. of Brooklyn.	100	1,500,000		....	115	120
" " " " Chicago..	100	750,000	....	....	170	180
" " " " Boston...	...	.....	....	....	130	140
" " " " Philadelphia.....	...	.....	....	....	130	131
Edison El. Lt. Europe....1,000		2,000,000	....	....	2	6
" Bonds....	...	30,000	....	. ..	80	85
Edison Ore Milling Co.... ...		2,000,000	....	....	12	17
East River El. Light.....	100	1,000,000	....	....	....	65
Fort Wayne Electric..... ...		.....	.	....	13	13¼
General Electric.	1,000	30,395,600	110½	111⅞	111¼	111½
Debenture 5's		10,000,000	100⅝	100¾	100½	100⅝
Automatic Exhibition Co. ...		2,500,000	. ..	....	3	5
Interior Conduit & Ins. Co.	100	1,250,000	...	...	66	68
Mt. Morris Electric..... ...		500,000	....	....	...	65
N. E. Phonograph.... ..		2,000,000	....	....	2	4
N. Y. Phonograph .. .		2,000,000	....	....	2	5
N. American Phonograph ..		2,000,000	....	....	4½	6
Westinghouse E & M. Co. 1st p. 7 per cent., Cum.	50	3,755,700	....	....	....	....
E. & M. Co. Assg.....	50	5,333,940	7¼	7¼	....	....

CHICAGO QUOTATIONS.

Following are the quotations of telephone and electric stocks furnished THE ELECTRICAL WORLD by C. V. Banta, Jr., 167 Dearborn street:

Telephone Stocks:	Bid.	Ask'd.	Electrical Stocks:	Bid.	Ask'd.
Chicago...	195	205	Chicago Light and Power Co.....	117¾	118½
Central Union	56		Chicago Edison Co	210	....

WALL STREET NOTES.

The Old Mucci Telephone Company, of which J. B. English, of Elizabeth, N. J., is president, according to report, is about to be revived and to begin operations. This company worked some years ago, using instruments of Mucci's invention, but the Bell telephone patents compelled it to suspend. Mucci, the inventor, was a comrade of Garibaldi, the Italian patriot. It is understood that the patent on the Bell telephone receiver expired last month and that it will expire on the Blake transmitter next month.

The Philadelphia street car syndicate, which aims to absorb all the lines outside the Philadelphia Traction Company, has effected an organization under the name of the People's Traction Company. The lease of the Second and Third by the Frankford & Southwark is believed to be in the interest of the company, and both roads will be turned over to it in a short time. The other roads will probably be secured. The new company is undoubtedly friendly to the Traction company. Among the directors are John Lowber Welsh, E. J. Matthews, R. A. Caren and W. H. Shermerdik. Mr. Matthews is a strong Traction man and Mr. Welsh is also friendly to the company.

Dividends payable Feb. 1: Edison General Electric, 2¼ per cent. quarterly; Edison Electric, Ill., 1¼ quarterly; General Electric, 2 per cent. quarterly. Books open: Phonograph Company, Feb 10; General Electric Company, Feb. 2.

The Massachusetts Gas and Electric Light Commissioner's annual report contains no recommendations. The number of companies in the State is 135; 26 supply gas and electricity, 40 gas only. Amount of gas sold by Boston Gas Light Company during the year, 1,870,060,562 feet by meter, and 41,277,450 by public lamps. The coal gas sold by the same company amounts to 1,397,890,700 feet.

The Harrison International Telephone Company has applied for a charter to operate telephones. The members of the directory are well known men throughout the country. The incorporators say they can give service for one half the rates now charged. The company will construct a circuit between New York, Boston, Buffalo, Cleveland, Detroit, St. Louis, Louisville, Cincinnati, Pittsburgh, Philadelphia, Washington, Baltimore and from there back to New York. This circuit will cost $10,000,000.

Coupons on the first mortgage 6 per cent. bonds of the Edison Light and Power Company, of San Francisco, due Feb. 4, are payable at the New York Guaranty and Indemnity Company, 59 Cedar street.

Copper Market.—Consumers have no difficulty in providing for their wants at 12.10 cents to 12⅛ cents for February and March delivery. At these figures large companies are not in the market. It is reported that the Calumet & Hecla is holding for 12⅛ cents. This condition indicates a very limited demand. Casting copper is in fair demand at 11⅝ cents to 11¾ cents. The exports of copper from the port of New York this last week consisted of 851,395 pounds of matte, valued at $37,000, and 751,537 pounds of fine copper valued at $77,307.

NEW INCORPORATIONS.

The Metropolitan Development Company, Norfolk, Va., capital stock $1,750,000, has been formed to operate electric works. The promoters are G. F. Brown, H. R. Knapp, R. Eldridge and T. S. Quinn.

The Stillaguamish Land Company, of Everett, Wash., has been organized to erect electric light plants, telephone and telegraph lines, etc. The parties interested are G. S. Brown and F. H. Brownell, of Everett.

The Hammond Light and Power Company, of Chicago, Ill., capital stock $50,000, has been formed to furnish light, heat and power. Marcus M. Towle, Frank J. Baker and Alonzo Stephens are the promoters.

The Oliphant Suburban Traction Company, of Oliphant, Pa., capital stock $36,000, has been formed to construct and operate an electric railway. T. Frank Jordon, Wm. McMahon and Jas. J. Cummings are the promoters.

The Calumet Electric and Manufacturing Company, of Chicago, Ill., capital stock $10,000, has been formed to manufacture and deal in general electric machinery, etc. Lucius A. Hine, Geo. E. Dorman and E. M. Ashcroft, are the promoters.

The Chicago-Topeka Light, Heat and Power Company, of Chicago, Ill., capital stock, $1,200,000, has been incorporated to manufacture and supply light, heat and power. Wm. Brace, John G. Campbell and Cornelius V. Smith are the parties interested.

The Conestoga Valley Railway Company, of Lancaster, Pa., capital stock $600,000, has been formed to construct and operate an electric railway from Lancaster to Reading. J. A. Coyle, J. W. B. Bausman and Wm. B. Given are the parties interested.

The Electric Appliance Company, of Portland, Me., capital stock $30,000, has been started to manufacture and sell electric and other machinery. Geo. B. Shepley, John Murray Marshall, Winchester, and Minott K. Kendall, of Melrose, Mass., are the promoters.

The Lawrence Gas Fixture Manufacturing Company, of Philadelphia, Pa., capital stock $10,000, has been formed to manufacture and sell electric and other fixtures, etc., etc. The parties interested are J. D. Harris, Franklin C. Paxon, J. Grier and R. Dickey.

The Electro-Chemical and Specialty Company, New York City, capital stock $100,000, has been organized to manufacture and deal in electrical chemicals, etc. J. C. A. Sutor, A. G. N. Vermilya, New York City, and A. R. Dix, Brooklyn, N. Y., are the incorporators.

The Phillips Electric Light and Power Company, of Philips, Me., capital stock $10,000, has been formed to establish and maintain an electric light plant in that town. John. W. Upp, Portland; Chas. E. Dalton and G. C. Hopkins, Deering, Me., are the promoters.

The Illinois Electrical Forging Company, of Chicago, Ill., capital stock $2,000,000, has been organized to manufacture and deal in electrical machinery, etc., and to furnish light, heat and power. Walter G. Campbell, John P. Skinner and Thomas Gratty are the promoters.

The Lancaster and Philadelphia Electric Railway Company, of Lancaster, Pa., capital stock $1,500,000, has been formed to construct and operate an electric railway from Lancaster to Bryn Mawr. The organizers of this concern are as follows: J. J. Patterson, J. J. Patterson, Jr., W. S. North, Lucien Banks and Robt. McMeen.

The Santa Cruz Electric Light and Power Company, of Santa Cruz, Cal., capital stock $300,000, has been incorporated to generate and develop electricity for all purposes, and to deal in electrical apparatus, etc. The promoters are Jas. McNeil, A. P. Swanton, F. W. Swanton, C. E. Lilly, and J. F. Appleby, all of Santa Cruz, Cal.

The Electrolier Manufacturing Company, of Newark, N. J., capital stock $100,000, has been formed to manufacture and sell light adjusters, call bells and electrical implements and apparatus. The organizers are B. E. Chapin, Newark, N. J.; Harry D. Sisson, C. H. Robinson, W. M. Wills, M. H. Haynes, Pittsfield, Mass.; Henry D. Sisson and E. T. Blodgett, Mill River, Mass.

The Patten Electric Power Company, of Jersey City, N. J., capital stock $100,000, has been formed to manufacture, build and equip, etc., dynamo electric machines, motors and electrical apparatus, etc. F. J. Patten, G. P. Shockley, New York City; J. C. McGuire, Wm. H. Burroughs, John Rooney, John A. Casey, Brooklyn, N. Y., and J. A. Helton, Jersey City, N. J., are the promoters.

Special Correspondence.

NEW YORK NOTES.

OFFICE OF THE ELECTRICAL WORLD,
167-176 TIMES BUILDING, NEW YORK, Feb. 6, 1893.

Mr. H. A. La Chicotte, eastern manager of the Wrought Iron Bridge Company, left for the South Saturday last, and will be absent about one week.

A course of lectures on practical electrical subjects will be given under the auspices of the Franklin Electrical Society at the Evening Trade School, 225 and 227 East Ninth street, New York City, through February and March. These lectures will be illustrated by experiments and stereopticon views. The first will occur on Feb. 11, the subject being "The Electrical Transmission of Energy," by Newton Harrison.

The American District Telegraph Company has increased its rates from 30 to 40 cents per hour for the use of its messengers, and also demands $6 as the yearly rental for its call boxes. The company states that the heavy expenses, including the cost of putting its wires under ground, has necessitated this action. The heavy increase, however, is resented by its customers and has caused considerable indignation on the part of the public. It is thought that the Postal Telegraph Company will now receive increased patronage wherever it can handle the business.

Mr. H. T. Richard, advertising manager of the *Electrical Review*, New York, has applied for a patent in the United States and foreign countries for a unique invention in connection with display electrical advertising in street cars operated by electricity. In the space usually devoted to advertising in street cars, where cardboard signs have heretofore been hung, there will be mounted in neat frames glass of any shade ground on one side and cut to the usual size of a street car panel; concealed behind this glass will be placed one or more incandescent lamps and, in some cases, reflectors of a suitable material. The advertising copy will consist of sheet-iron, tin or any opaque substance, that which corresponds to type, trademarks or designs being cut out of the opaque substance, so as to permit the rays of the electric lamps to shine through. Only one advertisement in the car will be illuminated at a time, which will make this form of advertising particularly striking, as the passengers will see one after another of the advertisements flashing out. The current is taken from the trolley, and a clock placed in the car will serve the double purpose of telling the time of day and periodically illuminating the panels.

ALBANY, Feb. 4, 1893.

The Deposit Electric Light Company has increased its stock from $12,000 to $24,000.

The Troy City Railroad Company contemplates extending its tracks up the hill in Cohoes.

An electric railway from the Northern Central Railroad station in Watkins to the Sanitarium and possibly to the Fall Brook depot is under discussion.

The project of building a street railroad between Waterloo and Geneva is again being agitated and parties are engaged in looking up the right of way.

A New York syndicate is contemplating the purchase of the Mt. McGregor Railroad. The trains will be operated by electricity in case the road is purchased.

Chairman Lewis F. W. Amend and Secretary L. L. Grove have filed a certificate of an increase to $75,000 in the capital stock of the Buffalo & Williamsville Electric Railroad Company.

The Hoosick Falls Electric Light Company has asked the village trustees for a renewal of the contract for lighting the streets of the village, the five-year contract having expired.

The Electric Service Company.—Forty thousand dollars is the amount of the capital stock of this company. The assets amount to $25,450 and the liabilities to $41,200. Henry W. Watson, Charles M. Morse, A. S. Donaldson and Samuel Ames as directors have filed their annual report.

Capt. I. W. Copeland, manager of the Western Union Telegraph Company in Troy, has resigned his position as signal officer on the staff of Brigadier General Oliver, commanding the Third Brigade. Captain Copeland has been on General Oliver's staff for two years and previously was on General Parker's staff.

Five handsome cars for the Cayadutta electric railroad have been sent to H. Ward Leonard & Co. Four are large double truck cars made by the Gilbert Car Company of Troy and the other is a single truck car from the establishment of J. G. Brill & Co., of Philadelphia. The larger cars are for through trains between Fonda and Gloversville, and the smaller ones, of which there will be seven, are for local travel between Johnstown and Gloversville. The former have baggage and working compartments. All are vestibuled and are heated by electricity.

The franchise for an electric light plant granted a short time ago to J. George Kaebler has been transferred to the Wellsville Electric Light, Heat and Power Company with the following officers: President, J. George Kaebler; secretary, Maurice O'Connor; treasurer, C. D. Crandall; directors, J. George Kaebler, Maurice O'Connor, C. D. Crandall, John McPherson and Charles Kaebler. The cost of the plant complete will be about $20,000, and it is expected to be in running order by the first of April. The plant will consist of a steam engine of 125-h. p. capacity, 75 arc lights of 2,000 c. p. (Western Electric Company's make), six miles of poles and wires and 850 incandescent lights (Westinghouse make).

An amateur electric telegraph company exists in Buffalo that is known as the West Side Private Telegraph Company. Private telegraph operating is carried on quite extensively in Buffalo. The three largest lines in the city are the Union, the Queen City and West Side, the last named being the largest of the three, having a membership of over thirty, and operating over fifteen miles of wire. The line is more for pleasure than for business. The constitution of the company limits the membership to 50 persons. An initiation fee of one dollar is charged, but after 40 members have been secured the fee will be raised to five dollars. The dues are $25 a month and the fund thus raised is used to purchase materia.

NEW ENGLAND NOTES.

BRANCH OFFICE OF THE ELECTRICAL WORLD,
Room 91, Hathaway Building, 620 Atlantic Ave.,
BOSTON, Mass., Feb. 4, 1893.

C. S. Knowles, 7 Arch street, Boston, in order to meet the demands of his trade, has opened branch offices in New York and Chicago.

The Belknap Motor Company, Portland, Me., has closed a contract with the Portland Stonework Company for a 150 light B. C. standard dynamo.

The Campbell Electrical Supply Company, Boston, Mass., is having a heavy run on Century splicing tape, which has been found to admirably suit the demands of the trade.

The American Telegraph and Telephone Company is to publicly open its long distance line between Boston and Chicago at 125 Milk street, Boston, on Tuesday evening, Feb. 7.

Swan & Lane.—The partnership recently existing between Mr. F. A. Swan and Frederick Lane has been dissolved, Mr. Lane retiring. Mr. Swan announces that he will still continue the business of the old firm.

The State Central Street Railway Company, Worcester, Mass., proposes to increase its capital stock $200,000. This will make the capital stock $650,000. It is also proposed to ask permission to cover new routes.

The Sawtell Company, 146 Franklin street, Boston, Mass., has removed its offices to Shawmut Building, Room 10. This company is the New England agent for the process of renewal of burned out lamps, and also for the Springfield Motor and Switch Company.

The Deane Steam Pump Company, Holyoke, Mass., recently held its annual meeting and elected the following officers: President, Theophilus Parsons; treasurer, C. H. Heywood; clerk, L. P. Bellows. Directors—Halmond E. Gaylord, G. W. Prentiss, P. Noor and C. P. Deane. The company declared an annual dividend of 6 per cent.

Pettingell-Andrews Company, Boston, Mass., has been appointed New England agents of the Siemens & Halske Electric Company, of America, and has also recently been appointed the sole selling agents for the Boston Electric Wire Company, which company will soon start on an extensive scale the manufacture of magnet wire.

The Mount Washington Glass Company, New Bedford, Mass., enjoys a world renowned celebrity for its productions in fine decorated and rich cut glass, such as Royal Flemish Albertine, Burmese, etc. This company has one of the finest equipped plants in America, and in the electrical line is an extensive manufacturer of incandescent lamp bulbs, shades and globes, and also arc globes. It also makes a specialty of silvered shades, commonly known as McCreary shades.

The numerous applications for charters for electric railways in all parts of the State of Connecticut has led Senator Root, of Waterbury, Conn., to introduce a bill providing for a new commission to exercise control over street railroads similar to that now exercised over steam railroads by the Board of Railroad Commissioners. The bill provides that the Governor, with the consent of the Senate, shall appoint three persons, a lawyer, an electrical engineer and a practical business man, to constitute a board of street railway commissioners, whose chairman shall be designated by the Governor.

The Engineers and Mechanics held their third annual ball at Odd Fellows Hall, Boston, Mass., which resulted in a great success, both from a financial and social point of view. The most attractive features were the decorations, in the preparation of which thousands of various colored incandescent lamps played a most important as well as attractive part. Not content with dazzling their guests and friends inside, they had placed on the roof of the building two large search lights, which added to the light which shone from dozens of arc lamps with globes of different colors which encircled the building.

The Massachusetts Chemical Company, Boston, Mass., manufacturers of the well known "Insullac" for electrical purposes, is meeting with unqualified success in its introduction. Its favor with electricians, motor manufacturers and street railway managers lies in the fact of its high resistance and waterproof qualities. Another advantage it possesses is that it does not require to be boxed. This company have established the following offices for the convenience of its extensive trade: New York, 60 Broadway, Col. Frank Dillont, manager; Philadelphia, Pa., 136 North Water street, Paul A. Davis, Jr., manager; Boston, Mass., 8 Oliver street, and C. S. Knowles, 7 Arch street, selling agents; Chicago, Ill., Monadnock Building, Wm. Bishop, manager.

WASHINGTON NOTES

WASHINGTON, D. C., Feb. 4, 1893.

The Brightwood Electric Railway Extension to Rock Creek Cemetery and Zoological Park is looked upon with favor by the Senate District Committee, Chairman McMillan having reported favorably upon it. These extensions will be equipped with the overhead trolley system.

The Inaugural Ball.—Elaborate plans for the illumination of the inaugural ball room are being considered, and it is expected that the electrical display on this occasion will eclipse anything of the kind heretofore attempted. Several companies are in competition for the work, the contract for which will probably be let very soon.

The Chesapeake & Washington Underground Railway is the name of another enterprise in railroading, for the incorporation of which a bill has been introduced into Congress. The motive power will be electricity, supplied from underground conductors. Messrs. J. Luttrell Murphy and John D. Parsons are among the interested parties.

Chesapeake & Potomac Telephone Company.—It is reported that this company will commence the erection of a building within a few months which will be occupied by its exchange and business offices. It will be a model structure of its kind, and its equipment will be of the most modern type and adequate to the great and growing demands of the National Capital.

The Washington & Arlington Electric Railway.—The Commissioners of the district have reported favorably upon the bill granting this company the right to use the piers of Aqueduct bridge. President King has stated that if the bill becomes a law his company will endeavor to have the line in readiness for Decoration Day. The Wheless underground wire system will be used upon the bridge.

Explosions in the Electric Light Conduits.—The many explosions which have occurred throughout the city during the last few months have been receiving the attention of Engineer Commissioner Captain Rossell and in his report upon the subject he states "that the explosions were due to the accumulating gas from faulty mains which was in some manner ignited and thus caused the explosions." He recommends that hereafter all conduits shall be closely watched and the manholes frequently uncovered to allow any accumulation of gas to escape. It is further recommended that future construction of conduits shall be ventilated in a manner similar to the method in vogue in New York City.

Washington, Mount Vernon & Alexandria Railroad.—The bill granting this road the right to build and maintain a bridge across the Potomac was up for discussion on Thursday, Feb. 2. The only objectors to the bill were a few Georgetown merchants who had fears of its interfering with commerce upon the river. Capt. Reed, vice-president of the road, explained that his company was now operating one of the best electric roads in the country: that it had introduced a novel feature, the running of express trains, never before attempted. The cars are so coupled that the electric current is transmitted to every car. The bridge is to be completed five months from the date of the passage of the bill.

The District of Columbia Suburban Railway Company has, by a bill recently introduced into Congress, secured an amendment to its charter permitting the company to operate a cable or electric road over the following route: Beginning on the old Bladensburg turnpike at the intersection of the railway of said company and M street (extended) to the Eastern Branch River, where the company is authorized to construct and maintain a bridge across said stream, on such plans as the Secretary of War may approve, and thence on M street still extended east to the avenue lying immediately to the west of the race grounds at Bennings; thence on said avenue southward to and through Deanwood station on the Baltimore & Potomac Railroad to Anacostia road; thence southwesterly on Anacostia road to Brentwood post office.

WESTERN NOTES.

BRANCH OFFICE OF THE ELECTRICAL WORLD,
465 THE ROOKERY, CHICAGO, Feb. 4, 1893.

The Illinois Electrical Forging Company, through its president, W. G. Campbell, gave an informal dinner to a number of representative manufacturers, merchants and professional men of Chicago, at the Victoria Hotel a few days ago. The guest of the evening was Mr. George D. Burton of Boston.

The Electric Appliance Company is congratulating itself on the way business has kept up through what is usually a very quiet month in the electrical supply line. The demand for its standard specialties, among which may be mentioned Paranite wire, Elkhart transformers, Whitney instruments, etc., is reported to continue to grow.

CLEVELAND, Feb 4, 1893.

The Woodland Avenue & West Side road began operating by electricity another of their lines, namely, the Detroit street route, on Saturday, Jan. 28.

Prof. E. P. Roberts recently delivered a very interesting popular lecture at the Y. M. C. A. Hall on electric lighting. The Professor spoke for something over an hour on the various methods of converting electrical energy into light, illustrating his remarks with experiments and lantern slides.

The ordinance to permit the electrical equipment of the St. Clair street road, at present operated by horses, was on Jan. 30 passed for the second time over the mayor's veto. The ordinance gives the Cleveland City Cable Railway Company the power to equip its cable lines also with electricity.

A cross town road in the East End has several times been proposed here, and it looks now as though the East End people were to be provided with this much needed convenience. The gift to the city of the Gordon property along the Lake Shore has infused renewed activity among the promoters of this plan.

The Universal Electric Light Company is the name of a new concern, prominent in which is Mr. N. S. Possons, the former superintendent of the Brush Electric Company's works in this city, which is pushing a lighting plant for the East End. They are now endeavoring to procure from the city permission to erect their lines. They propose to confine their operations to the territory east of Wilson avenue.

The change in the officers made at the annual meeting of the East Cleveland Railway Company has taken place. Mr. H. A. Everett has succeeded Dr. A. Everett as president, Mr. Chas. W. Wason is vice-president, while Louis E. Beilstein is now secretary and treasurer. It is said that the new management will proceed immediately to increase the present equipment of the road, both in rolling stock and at the power plant. Thirty cars of the Mehling type will be built at once and put in service, while the trailers will be retired as rapidly as possible. The point aimed at is a three-minute schedule on the main line. The suburban service is also to be improved.

An ordinance was recently brought before the City Council by Councilman McKinney to grant to such individuals, company or corporation as should bid to carry passengers at the lowest rates of fare the right to construct an electric railway from the centre of the town along Superior street to Wood, there turning down to Lake street and running to Gordon Park, thence back to St. Clair street, cross town on Giddings avenue to Woodland, thence to some southerly point as the proper authorities should designate. The ordinance provides for a low rate of fare, transfer checks, the paving of certain portions of the street, and the building the line in compliance with the wishes of the board of control, also that the portion of the city through which the new road shall run should be free territory, and that the route shall be in running order by Jan. 1, 1894. The ordinance came up again before the Council on Jan. 30, and it appears that more than one party is after the route, Councilman McKinney having introduced the ordinance for one set of capitalists, while Mr. A. L. Johnson, president of the South Side Railway Company, with Secretary Davies of the same company, has visited the city hall and had a talk with General Meyer, in whose hands the ordinance now is concerning the plan. Mr. Johnson states that he together with M. A. Bradley and Chris Grover are ready to build the road if they can get the grant, and further that if they can obtain the grant shortly they will have the road completed by July 4. Mr. Johnson's scheme of equipment, if followed out, will make the new road the finest in town. He proposes to do away with the trailers, and put on cars large enough to seat 50 people.

News of the Week.

THE TELEPHONE.

Telephonic communication between New Brunswick, Mass., and Martha's Vineyard was established for the first time on Jan. 29, and the line worked very successfully.

The Long Distance Telephone Company, of Providence, R. I., is making arrangements to introduce the service on the Island of Jamestown. A cable line will be run from Coaster's Harbor Island across to Potter's Point, whence lines will be extended north to Conanicut and south to Jamestown, where the central station will be located.

THE ELECTRIC LIGHT.

Knoxville, Ill., wants its streets lighted by electricity.

Algonquin, Ill., will soon be lighted by electricity to be supplied from the Dundee power house.

The Bridgeport Electric Company, of Bridgeport, O., has added to its plant a 1,000 16 c. p. incandescent machine.

Roanoke, Va., has awarded the contract for lighting the city by electricity to the Roanoke Electric Light and Power Company.

Des Moines, Ia.—The Capital City Gas Light Company and an Eastern corporation has absorbed the electric light plant of the Des Moines Water Power Company.

Mayor Matthews, of Boston, Mass., in a recent communication to the Common Council, took occasion to state that the city was paying altogether too much for the lighting of its streets.

The Elkton (Md.) Electric Light and Power Company's plant was started on Jan. 21. The system used is the Thomson-Houston alternating. The company has secured the city lighting for the coming year.

The Thomson-Houston Company has brought suit for $170,000 against the City Electric Company, of Little Rock. The Atlantic Trust Company, of New York, is trustee for $600,000 of its bonds, on which interest is part due.

Enterprise.—The Buffalo General Electric Company repaired the damages done to the Thomson-Houston station at Buffalo on Dec. 15 last with commendable promptness. Mr. C. R. Huntley, the manager, on the same day of the fire put in two new machines, and a few days after started up with 15 Thomson-Houston dynamos and a D 32 power generator, giving a capacity of 500 arc and 9,600 incandescent lights. The total loss was $39,000, with $29,000 insurance.

Quick Work.—Mr. C. H. Hines, electrician of the Empresa Alumbrado Electrico de Tampico, Mexico, recently installed a plant consisting of 75 arc lights, 50 series incandescent, a 70 h. p. Bass boiler, a 64 h. p. N Y. Safety engine, and two Ball 50-light dynamos, in a remarkably short time. Work was commenced on Nov. 9, and lights were burning on Dec. 7, while the whole town was lighted on Dec. 21. This was accomplished with very poor native help.

Brilliant Lighting Effects.—At the "King Cotton Ball," the great society event of the season given by the "Association to Preserve Virginian Antiquities," of Richmond, Va., on Jan. 27, at the Mozart Academy, the beauty of the electrical designs used in decoration drew forth universal expressions of praise. Six hundred 16 c. p. incandescent lights in colored globes were used, the colors being red, white and blue. They were so disposed as to give the most artistic effect possible, and the light was beautifully soft and mellow. As it was a distinctly Southern affair the thirteen Confederate States were each represented by a lovely star, formed of lamps and placed round the galleries. Between the stars were placed groups of palms, from amid the foliage of which three lights shone with really splendid effect. Across the proscenium arch the initial letters of the Society, A. P. V. A., in large capitals, were also formed of the lamps in the different colors. Among the dark green foliage of the palms and other plants many lights were distributed, and the effect was more than beautiful. The electrician, Mr. T. L. Martin, who designed and executed the arrangement is to be congratulated on his signal success. The lights were furnished by the Richmond Electric Railway and Light Company.

THE ELECTRIC RAILWAY.

Carterville, Mo.—A site for the power house for the street railway has been secured and a brick structure will be erected.

A new electric railroad is proposed to be run on the old Paterson plank road from Passaic City across the Hackensack River by way of Secaucus bridge.

Wellesville, N. Y.—The franchise for an electric light plant granted a few weeks ago by the trustees of the village of Wellesville to J. S. Kaebler has been transferred to the Wellesville Electric Light, Heat and Power Company.

The Detroit Citizens' Street Railway Company at a recent meeting of its directors voted to enter into a contract with the Pullman Car Works for the construction of 31 open summer cars, 17 summer cars to which trailers can be attached, and 12 closed motor cars, the cars to be ready for delivery in May, when they will be put in active service.

LEGAL NOTES.

Right of City Council to Grant Franchise to Electric Railroad.—Where the charter of a city provides that the Common Council shall have the power to authorize the use of the streets for horse and steam railroads, the words horse and steam railroads are not words of limitation, and the Council is empowered to grant such franchises to electric railways.—(Buckner v. Hart, U. S. Circuit Court of Louisiana, 52 Fed. Rep., 835.)

Liability for Injury on Electric Railway.—In an action against an electric street railway company for injury to a passenger from a plank on the track, the questions of fact involved being whether the company placed the planks there, whether it inspected its tracks with reasonable frequency, whether the motorman kept a sufficient lookout, and whether the brake was efficient; and it appearing that the company was in the habit of carrying on open cars more passengers than could be accommodated with seats, and that a speed of 15 to 20 miles an hour was not considered unreasonable by it, and that it was customary to let the car run down grade by gravity, leaving it dependent for stoppage on the brake, an instruction cannot be complained of for requiring of the company and its employés extraordinary care and diligence.—(Cogswell v. West St. & N. E. Ry. Co., Supreme Court of Washington, 31 Pac. Rep., 411.)

Delay in Transmitting Message.—A dispatch was left at a telegraph office to be forwarded to another city. The dispatch was: "Strauss gone to Howard. Gave man gold watch by mistake. Left no word with me. Store closed. Answer." Strauss was a clerk, whom the man sending the message had left in charge of his jewelry store in his absence, and during the night or early in the morning, before the dispatch was sent, had robbed the store and absconded with the property, and the dispatch was in relation to the absconding, but the telegraph company's agent had no notice thereof. The dispatch was not transmitted for an hour and a half, and then it remained in the office to which it was forwarded for two hours before it was delivered or any effort made to deliver it. Held, that the jeweler could not recover more than the cost of the message and incidental expenses.—(Western Union Telegraph Company v. Cornwall, Court of Appeals of Colo., 31 Pac. Rep., 394.)

Taxes on Corporations is likely to receive some more attention from the Legislature of New York State at the present session. A committee appointed to report on the whole subject of taxes recommends that a board of tax commissioners be empowered to tax the property of all transmission and transportation companies, including railroads, telegraph, telephone lines, etc. It would be the duty of the board to fix the value of the entire property of such a corporation running through different towns and counties, and the proportion should be placed upon the tax roll in the tax district, thus relieving the assessors entirely. The corporations organized outside the State would pay an organization tax similar to that paid by home corporations, based upon the amount of capital employed in New York State, and the franchise tax now provided for would be extended so as to include all foreign corporations doing business in this State.

PERSONALS.

F. P. Little, manager of the F. P. Little Electrical Construction and Supply Co., of Buffalo, N. Y., will be present at the convention in St. Louis.

C. R. Huntley, manager of the General Electric Light Company, of Buffalo, N. Y., will attend the National Electric Light Convention in St. Louis.

Dr. H. S. Bishop, president, and I. H. Babcock, treasurer, of the American District Steam Company, of Lockport, N. Y., will represent their company at the Convention of the National Electric Light Association in St. Louis.

Mr. Charles Plum, of Buffalo, N. Y., has been confined to his house for the past three weeks by sickness, caused by pressure of business and the responsibilities of the police telegraph system, of which he is superintending electrician.

M. Van Rysselberghe, of Antwerp, died on Feb. 1. He was a well known electrician, being prominently connected with the introduction of the telephone in Belgium and elsewhere in Europe. He was the inventor of the meteorograph.

MISCELLANEOUS NOTES.

A Correction.—In THE ELECTRICAL WORLD of Jan. 21 it was stated that the Philadelphia Fire Underwriters' Association had adopted the silk wipers of the American Silk Manufacturing Company in place of cotton waste. This was a mistake, as the association merely indorsed them, and could not from the nature of the organization adopt or use them.

Engineering Association of the South.—The January meeting of the association was held at the association rooms in Nashville, Tenn., on Thursday evening, Jan. 12, 1893, Maj. E. C. Lewis presiding. Mr. Hunter McDonald, who had been appointed to prepare a memorial on the late Col. R. C. Morris, chief engineer of the Nashville, Chattanooga & St. Louis railway, submitted the memorial, which was accepted, and ordered to be printed in the publication of the society. Applications for membership were received from Mr. E. N. Pegelsen, of Pineville, Ky., and from Mr. J. Hill Akin, of Nashville, Tenn. Mr. Hunter McDonald was appointed to prepare a memorial on the late Berrien L. Blackie, assistant engineer N. C. & St. Louis railway. Maj. W. E. Foster presented a description of the development of the water power at Estill Springs, Tenn.

Industrial and Trade Notes.

William F. Breidenbach, agent of Alexander, Barney & Chapin, reports business as very active in his line.

The application of the Electrical Supply Company, of Ansonia, Conn., to change its name to the Ansonia Electric Company has been granted by Judge Prentice of the Superior Court at New Haven.

Rudolph Schmidt & Co., of Rochester, N. Y., are doing considerable business in the line of wiring and electric bell work. They have just completed an order for wiring and supplies for the Eureka Club, and for a number of other plants.

Hine & Robertson, 57 Cortlandt street, New York City, recently filled an order for 50,000 pounds of "Eureka" packing, which is perhaps the largest single sale on record, and is conclusive evidence that Eureka packing is finding favor among engineers.

The Buffalo Steam Pump Company will, in a few days, remove to its new shops at Tonawanda, N. Y. These will consist of two brick buildings, one 300 × 80 ft., and the other 380 × 80 ft., together with four acres of ground and other smaller buildings.

The Davis Electrical Works, of Springfield, Mass., have issued a neat calendar in the form of a two-leaved folder. This company makes a specialty of renewing burned-out lamps, that is, opening them, cleaning them, and replacing the filament by a new one.

Messrs. Taylor, Goodhue & Ames, Monadnock Building, Chicago, Ill., have issued an interesting little pamphlet describing the Diamond transformers, fully illustrated, and containing in addition considerable information in regard to the use of transformers, which is intended for the use of practical men.

The Genett Air Brake Company, of 150 Broadway, is busy filling orders for its air brakes, which are being placed upon the electric cars in Brooklyn, N. Y., and St. Louis, Mo. This company is making many improvements at its works in Chicago, the better to handle its large and increasing business.

The Straight Line Indicator has awakened considerable interest in foreign countries. Hine & Robertson, 57 Cortlandt street, New York, inform us they have sent indicators during the past week to the Royal Naval Academy, Woolwich, England, and to the Georgetown Electric Light Company, British Guiana, S. A.

Mr. T. J. Murphy, 136 Liberty street, reports that during the past four months his business among the electrical fraternity has increased three-fold. Mr. Murphy now ships to New York plain marble, doing all the drilling, filing, cutting and fitting here, thus avoiding the chipping and scratching incident to transportation.

The American Silk Manufacturing Company, 311 Walnut street, Philadelphia, Pa., is gratified at the way in which its silk wipers are replacing cotton waste. It is claimed that if silk wipers had been used in the mill of Bachman & Co. the fire would not have occurred, which resulted in the destruction of the mill and a loss of $225,000.

Boston Motor Company, Battery March street, Boston, Mass., manufactures a little motor which it sells complete for the price of $1, under a patent granted to the company on Nov. 15, 1892. The company states that other parties have been infringing upon its patent, and placing upon the market a similar form of motor and battery of inferior quality.

The Carpenter Enamel Rheostat Company, Bridgeport, Conn., Chas. D. Shain, general selling agent, 136 Liberty street, New York City, has issued a neat little pamphlet containing a complete description of its well known rheostats, with illustrations of various types and sizes, together with other information of interest to those in any way connected with such work.

The American Electric Supply Company, of Buffalo, N. Y., reports its business as rapidly increasing. It has recently wired the Erie County Bank building, furnishing all the supplies. This is the largest stone building in Buffalo. It has also installed isolated plants for Charles Schoeffin & Co., Gardenville, N. Y., 175 and lights for the National Car Wheel Co., Depew, N. Y., 150 lights.

The Berlin Iron Bridge Company, of East Berlin, Conn., will build the new machine shop for S. F. Hodge & Co., Detroit, Mich. The building will be 150 feet long and of the modern type, the central portion being 40 feet in width, controlled by a traveling crane of 20 tons capacity, with a wing on each side 22 feet in width, the wings being two stories high. When completed it will be one of the best machine shops in the Northwest.

The Electrical Repair Works, of Buffalo, N. Y., composed of A. A. Temple and R. D. Busset, Jr., have established their workshop at 327 Washington street, Buffalo, where they have facilities for all kinds of electrical repairing, and especially for armature rewinding and transformer work; they also propose to do testing for electrical and steam plants, to handle new and second-hand electrical apparatus, manufacture dynamo brushes, etc.

Queen & Company, Incorporated, Philadelphia, report a steady demand for their portable photometer, which instrument accurately measures the candle power of incandescent lamps, and can be used wherever desired. It is very important, from an economical standpoint, for a central station manager to use lamps that give the greatest illumination for energy consumed, and this convenient apparatus enables comparisons of different types to be quickly made.

Mr. W. R. Brixey, 203 Broadway, New York, manufacturer of the Kerite insulated wires and cables, has received a contract from the American Telephone and Telegraph Company to lay across the North River two lengths of 18 conductor Kerite submarine cables, 5,300 feet each. This, making nine cables of this character placed in the North River by Mr. Brixey for this company, shows a well merited appreciation of the quality of goods manufactured by him.

Dissolution of Partnership.—The partnership lately subsisting between Charles R. Truex and William A. Vail, conducting business under the firm name of Truex & Vail, at No. 136 Liberty street, in the city of New York, N. Y., has been dissolved by mutual consent. All debts owing to the said partnership are to be received by William A. Vail, and all demands on the said partnership are to be presented to him for payment, as he is authorized to settle all debts due to and by the firm.

The Onondaga Dynamo Company, of Syracuse, N. Y. has received letters from the Empire Drill Company, Shortsville, N. Y.; the John Marsellus Manufacturing Company, Syracuse, N. Y.; the Gouverneur Machine Company, of Gouverneur, N. Y.; the Brownville (N. Y.) Iron Works; the Globe Paper Company, of Brownville; the Cato (N. Y.) Wagon Hub Manufacturing Company, and others, expressing the greatest satisfaction with the apparatus which the Onondaga company has installed in their shops and factories.

The Buffalo (N. Y.) Electric Construction Company has opened new offices in the Laird Building, Niagara street, Buffalo. This is a new firm recently organized with ample capital for contracting for and constructing electric light and power plants, and also dealing in electrical supplies of all kinds. H. V. Ford, the general manager, recently came to Buffalo from Hornellsville, N. Y., where he started years ago as messenger with the Western Union Telegraph Company. The company starts out with good prospects of success.

Chas. F. Burns & Co., Rochester, N. Y., is a new firm in electrical engineering and electrical supplies. They have opened their store at 21 South St. Paul street, where they expect to keep a full stock of all kinds of electrical supplies and do electrical repairing. Mr. Chas. F. Burns is well known in the electrical field, having been with the United States Electric Lighting Company, New York, for some time. For the past five years he has been electrician for the Rochester Electric Light Company. Their store is centrally located and very suitable for the business.

The American District Steam Company, of Lockport, N. Y., which is introducing the Holly system of using exhaust steam for heating purposes, is very busy filling its orders. The Cedar Rapids Electric Light and Power Company recently put in 2½ miles of this system, and is heating 2,500,000 feet of space. The Springfield Electric Light and Power Company is heating 3,000,000 feet of space, while the Ottumwa Electric Railway Company has three miles installed, with 300 customers. Many other companies have adopted this system and found it to work with great success.

The Snow Steam Pump Works, Buffalo, N. Y., which two years ago bought several acres of land and built two large shops has now found its business so much increased that it is necessary to again build. The new building is a brick, iron and steel structure, 300 × 90 feet, and two stories high. It will be equipped with the latest and best facilities and apparatus, including a 15 ton traveling crane. This company will manufacture pumps from the smallest sizes up to 20,000,000 gallons capacity a day, water-works, engines, etc. It now has agencies in all the large cities.

The Riker Electric Motor Company, 45-47 York street, Brooklyn, N. Y., has issued a handsomely illustrated catalogue descriptive of the apparatus manufactured by it. This company makes a specialty of electrical apparatus for marine use, and its direct coupled marine dynamos and engines are now widely known, having been installed on well known steam yachts such as the Vamoose, the Linta, and the Orienta. The Riker Company also manufactures searchlights of various types, storage batteries, and fixtures for marine work. Its electric launches and tenders have proved to be very popular, and have been adopted by the owners of a number of yachts.

The Ball Engine Company, Erie, Pa., reports the following among the number of sales recently made by the Chicago office: Calumet Electric Street Railway Company, Chicago, four 300-h. p. cross compound electric railway engines; Hammond Electric Street Railway Company, Hammond, Ind., one 150 h. p. steam plant complete; H. D. Bentley, Freeport, Ill., one 35-h. p. steam plant complete; Elmwood Electric Light Company, Elmwood, Ill., one 150 h. p. engine; Union Passenger Station, Chicago, one 125-h. p. engine; Keith Bros. & Co., Chicago, one 50-h. p. engine; Marengo Electric Light Company, Marengo, Ia., one 100-h. p. steam plant complete; Scott & Royce, Griggsville, Ill., one 50-h. p. steam plant complete; Western Light and Power Company, Chicago, one 300-h. p. engine; Englewood Electric Light Company, Chicago, one 500-h. p. cross compound engine.

Frank R. Chinnock, 18 Cortlandt street, New York, Eastern agent of the Ball Engine Company, of Erie, Pa., reports large sales of this well-known engine throughout his territory. The following are among the recent orders he has filled: Buffalo, North Main & Tonawanda Street Railway Company, Tonawanda, N. Y., engines; Ithaca Street Railway Company, Ithaca, N. Y., complete steam plant; Seabury & Johnson, East Orange, N. J.; Hahne & Co., Newark, N. J.; Dow's Stores, Brooklyn, N. Y.; Casa Alameda Hotel, Sixty-fifth street and Columbus avenue, New York City, two large engines; Lakewood Casino, Lakewood, N. J., complete steam plant. The Ball Engine Company recently issued a handsome descriptive catalogue, and Mr. Chinnock would be glad to furnish it to any one desiring information on automatic high-speed engines for electrical purposes.

F. P. Little, of the Electrical Construction and Supply Company, Buffalo, N. Y., is now settled in his new quarters at 125 Seneca street, where it will occupy the whole building, and carry a large stock of electrical apparatus and supplies for incandescent lighting and power transmission plants. This company is selling agent for the Kester arc lamps, the Meston fan motors, Crocker-Wheeler dynamos and motors, Salamander wires, Bryant switches

and cut-outs, Case automatic high speed engines, and various supplies of other well known manufacturers. Mr. F. P. Little, manager has for years been well known in the electrical field. Among some of the recent shipments may be mentioned four tons of wires, at large order, for supplies, to the Niagara Falls and Electric Light Company, Ontario. This company has also installed a large number of isolated plants, and is doing an excellent business.

Business Notices.

Transformers rewound and repaired. Write for prices. The Hill Manufacturing Company, Salem, Va.

Oil Filter for sale cheap; send for prices to Purity Oil Filter Manufacturing Company, 201 Water street, Pittsburgh, Pa.

Battery Cut-Out, Cheap.—Sensitive, reliable, never requires attention. Gas lighting much improved by its use. Electric Supply Company, of 105 South Warren street, Syracuse, N. Y.

Johnston's Electrical and Street Railway Directory.—What others say of it:

"Johnston's Electrical Directory, 1892, is well gotten up; neat and tasty; typographically excellent; ornamental and useful; I like it."—Cleverly, Philadelphia, Pa.

"The book is handsomely gotten up and seems to contain the information required. The headings are particularly commendable."—American Circular Loom Company, Boston, Mass.

"We think the book very valuable."—American Watch Tool Company, Waltham, Mass.

"Think it is an admirable publication of great benefit to all parties interested in electrical goods."—Onondaga Dynamo Company, Syracuse, N. Y.

"Very handsome—a most useful article."—Viaduct Manufacturing Company, Boston, Mass.

"We expected to see the best work of this kind and are not disappointed. We are very much pleased with it."—Redding Electric Company, Boston, Mass.

"It needs only a casual examination to convince me that you have surpassed all previous efforts in this line."—E. H. Cutter, Manager Elektron Manufacturing Company, Springfield, Mass.

"A very fine copy and very satisfactory."—Pettingell-Andrews Company, Boston, Mass.

"Your enterprise in producing such a valuable work should be appreciated by the electrical trade."—Loando Hard Rubber Company, Boonton, N. J.

"A comprehensive ready reference covering the electrical field, valuable to manufacturers and dealers in electrical goods and apparatus."—Standard Electrical Works, Cincinnati, O.

"We are very well pleased with it and think it will be of immense benefit to us in buying and selling."—Delaware Electric and Supply Company, Wilmington, Del.

"A very perfect volume."—Bernstein Electric Company, Boston, Mass.

"I am very much pleased with the book."—W. Warren Thread Works, Warren, Mass.

OUR ILLUSTRATED RECORD OF ELECTRICAL PATENTS.

[In Charge of W. A. Rosenbaum, 177 Times Bldg., N. Y.]

UNITED STATES PATENTS ISSUED JAN. 31, 1893.

490,641. Insulating Compound; M. W. Dewey, Chester, Pa. Application filed Jan. 30, 1892. A composition consisting of powdered slag, glass, boiled linseed oil, driers, shellac and paraffine.

490,663. Electric Block Signal System; John La Burt, New York. Application filed Dec. 14, 1891. The combination with the semaphores and the eccentrics connected therewith, the eccentrics having an insulated conducting face, of insulated track sections connected with electric contacts arranged in the paths of the eccentrics, and an electrical signaling apparatus carried by the locomotives and having electrical connections with the wheels of the locomotive, whereby the circuit will be closed through the apparatus by the contact of the wheels with the track sections.

490,678. Apparatus for Electrically Treating the Eyes; William A. Price, Iowa Falls, Ia. Application filed Sept. 24, 1892. A device for treating the eyes, which consists of a metallic frame provided with arms for holding it on the head, in combination with electrodes formed of absorptive material secured to and in electrical contact with the frame and in such juxtaposition as to bear against the eyes of the patient, and insulated conductors leading to a generator.

490,679. Apparatus for Electrically Treating the Ear; Wm. A. Price, Iowa Falls, Ia. Application filed Sept. 29, 1892. This device consists of a conductive skeleton frame for treating the outer portions and drum and tympanum of the ear. (See illustration.)

490,684. Automatic Alarm Device; G. W. Schilling and John G. Haslam, Philadelphia, Pa Application filed June 18, 1892. In an automatic alarm device for pipes, the combination of a main pipe, a main movable part located therein and operated automatically by the pressure in the pipe, the main pipe having a communicating passageway from one side of the main movable part to the other, a second automatically movable piece closing the passageway, and operating at a lower pressure than the main movable part, and alarm and connections respectively between the main movable piece and the second movable piece.

No. 490,679.—Apparatus for Electrically Treating the Ear.

490,698. Electrical Time-Indicating Apparatus; Edward Weston, Newark, N. J. Application filed June 16, 1891. Two loop conductors connected in circuit and pivoted in fields of force, and in combination with one of the conductors and actuating the same, a motor and a means of arresting the movements of the motor at predetermined intervals, and in combination with the other conductor and controlled by the movement thereof.

490,699. Recording Ammeter; Edward Weston, Newark, N. J. Application filed March 18, 1892. A coil in an electrical circuit supported and vibrating in a field of force, an arm actuated by this coil, a tracing device controlled by the arm, a moving record surface on which the tracing device marks, means for controlling the direction of the current in and consequent direction of vibration of the coil in accordance with the rise and fall of current strength in the circuit.

490,700. Electrical Measuring Instrument; Edward Weston, Newark, N. J. Application filed March 29, 1892. An electrical measuring instrument containing an expansible wire or filament in circuit and an index controlled by the expansion of this wire, a support for the wire constructed of an alloy having the same coefficient of expansion of the wire.

490,725. Electrical Pressure Indicator for Steam Gauges; Edward G. Smith, San José, Cal. Application filed July 6, 1892. The combination of a pressure pointer journaled in the gauge, an adjustable circuit closing pointer journaled on the arbor of the pressure pointer, a non-conducting support on the rim of the gauge, circuit wires held in the support, adjustable arms on the wires, standing with their free ends normally open, and arranged to receive the end of the adjustable circuit-closing pointer and establish the circuit.

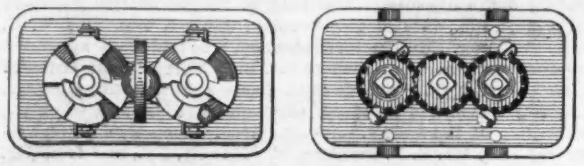
490,744. Electric Time System; Wm. F. Gardner, Washington, D. C. Application filed Dec. 13, 1888. This method consists in imparting electric impulses to a main line and causing these impulses to close local circuits, each through a polarized relay by a current of given polarity, and in testing such main line by imparting thereto a current of opposite polarity and reversing the direction in which the last current traverses the magnets of the polarized relays.

490,746. Electric Switch; J. S. Gibbs, Hartford, Conn. Application filed Nov. 1, 1892. The switch has, in combination with an insulating base having two series of annularly arranged insulating ratchet teeth formed integral with the upper surface and a double set of stationary contact pieces secured thereto for the attachment of the circuit wires, double revolving pole-pieces pivoted in the centre of each series of teeth, a single key and a connection between the keys and both of the revolving pole-pieces. (See illustration.)

490,753. Secondary-Battery Electrode; Harry G. Osburn, Chicago, Ill. Application filed Nov. 21, 1891. This electrode consists of a grid or plate having a multiplicity of connected ribs or bars which are deflected in opposite directions, and form open receptacles for active material, a reinforcing conductor extending through the receptacles and the filling of active material.

490,755. Connector for Electrical Conductors; Geo. L. Russell, Middletown, Conn. Application filed Aug. 12, 1892. A connector for electric conductors, consisting of a plate bent twice at about right angles, a clamping piece similarly bent, and ending in a downwardly extending hooked portion and a screw for fastening them together.

490,760. Electrical Measuring Instrument; Edward Weston, Newark, N. J. Application filed Oct. 3, 1892. In an electrical measuring instrument, two stationary coils, two coils wound in opposite directions having a common diametrical pivot and vibrating respectively in the fields of the stationary coils, and a spring opposing and counterbalancing the impressed action of these movable coils.



No. 490,746.—Electric Switch.

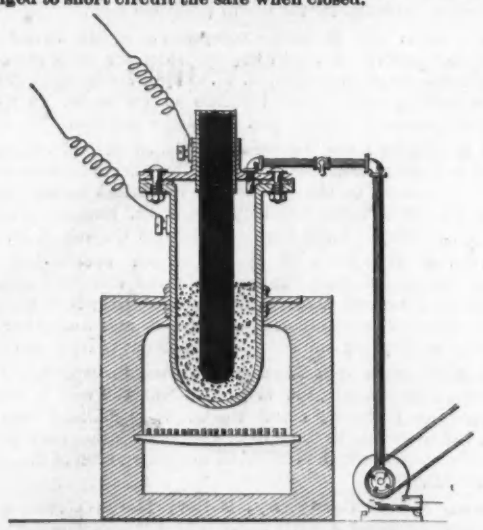
490,761. Electric Signaling System; Adoniram J Wilson, Port Chester, N. Y. Application filed Sept. 14, 1892. The combination of a main signaling circuit, a circuit controller in the main circuit operated by a moving train and located at the entrance of a guarded block or section, a circuit breaker in the main circuit, a clear circuit controlling the circuit breaker, a circuit changer in both the signaling and the clear circuits, an electromagnet controlling this circuit changer and controlled by a device located within the guarded block or section and operated by the moving train, a circuit controller located at the exit end of the block and adapted to be operated by the moving train, and thus operate the clear circuit and circuit changer whereby the clear circuit and the signal circuit are restored to normal.

490,762. Electric Current Breaker; Edward M. Bentley, Boston, Mass. Application filed Nov. 19, 1892. An electric circuit breaker having a traveling arm or lever as one member, with a compressor moving with the arm and automatically delivering air or like insulating fluid across the arcing space at or near the instant the circuit is broken.

490,809. Dynamo-Electric Machine; Robert Lundell, Brooklyn, N. Y. Application filed April 22, 1892. This machine has a disc armature and a single field magnet core provided with radially disposed multipolar pole pieces magnetized by a single field magnet coil lying in a plane on one side of the armature and parallel to it.

490,810. Dynamo-Electric Machine or Electric Motor; Robert Lundell, Brooklyn, N. Y. Application filed April 22, 1892. A dynamo-electric machine having two hollow disc shaped field magnet cores, each having radially disposed multipolar pole pieces in combination with two enclosed field magnet coils located on opposite sides of the disc-shaped armature and in planes parallel to the same.

490,870. Electric Burglar Alarm; Warren Henry Carr Bath, Me. Application filed Sept. 22, 1892. This invention comprises an electro-mechanical annunciating and indicating apparatus located at a central station and included in an electric circuit, and an electric circuit fed by a suitable source of electricity and extending from the station to a distant safe, of a rectangular, wholly metallic casing, surrounding the safe and insulated therefrom by an air space, a circuit controlling lock on the safe door and included in the same electric circuit, a controlling switch for the circuit located near the safe, and a push button included in a multiple arc branch from the main circuit, the branch being arranged to short circuit the safe when closed.



No. 490,953.—Art of Generating Electricity.

490,882. Telethermometer; Howard B. Payne, Chicago, Ill. Application filed May 20, 1892. In an electrical apparatus for use in indicating temperature, the combination with an electric generator and a telethermometer in a circuit thereon, an indicator comprising a case supporting electromagnets in circuit with a thermostat, an arbor pivotally supported in the case and carrying an armature and index finger and a dial.

490,883. Telethermometer; Howard B. Payne, Chicago, Ill. Application filed Sept. 22, 1892. An electric temperature apparatus comprising in combination with an electric generator and its circuit, and a telethermometer having contacts, an annunciator having electromagnets each connected with a different contact, and all with one pole of the generator, and provided with pivotal armatures provided with extensions carrying signs and a circuit closer in the circuit.

490,891. Electric Warming Bottle; Thomas Ahearn, Ottawa, Canada. Application filed Sept. 8, 1892. The combination of a bottle or bag of flexible waterproof material, and a long neck with a mouth therein, a resistance coil within this bottle and leads extending through the neck.

490,903. Combined Gas and Electric Light Fixture; Francis X. Gartland, Philadelphia, Pa. Application filed Jan. 23, 1892. A coupling for electric conductors having knuckles with an interlocking plug, contact rings in insulating discs in these knuckles, pipes on the knuckles provided with openings for the conductor, the plugs having a bore opening on different sides of it.

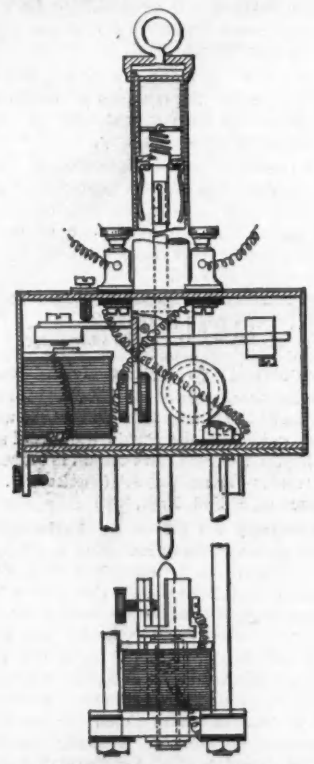
490,917. Switch and Safety-Fuse; Elmer P. Morris, Boston, Mass. Application filed Feb. 11, 1892. The combination of a box containing a rotary switch having a spindle, a cover for the box traversed by the spindle, and having contact plates with a fuse connected to it, contacts in the box connected to the line and the switch and engaging with the contacts on the cover and a bead or projection on the cover engaging with the box.

490,948. Electric Belt; J. W. Cummings, Gold Hill, Nev. Application filed July 27, 1892. In an electric belt, a battery composed of a series of cells, each cell consisting of a zinc plate folded upon itself and punctured as described, a wrapping of narrow absorbent tape entirely surrounding the zinc plate, and the copper plate folded around the absorbent packing and having a longitudinal groove and the connecting wire uniting the cells, the copper plate being provided with longitudinal grooves to receive the wire.

490,953. Art of Generating Electricity; Thomas A. Edison, Menlo Park, N. J. Application filed Nov. 1, 1823. This invention consists in an improvement in the art of generating electricity, consisting in causing cumulative or reciprocal dry chemical reactions under conditions of heat and rarefaction in presence of electrodes charged thereby. (See illustration.)

490,954. Manufacture of Carbon Filaments for Electric Lamps; Thomas A. Edison, Llewellyn Park, N. J. Application filed Nov. 6, 1886. This invention consists in an improvement in the method of manufacturing carbon filaments for incandescent electric lamps, consisting in first forming filaments of carbonizable material, then partially carbonizing them before they have been soaked or otherwise similarly treated, then soaking the same in a solution of a carbonizable substance, and then completely carbonizing the whole.

490,959. Coupling of Dynamo-Electric Machines in Parallel; Albert Gay, London, England. Application filed Jan. 11, 1892. In a parallel arrangement of dynamos the combination with a number of dynamos, external circuits, and main fuses or cut outs connecting the terminals of each of the dynamos to one of the external circuits, of two conductors and two series of auxiliary fuses or cut-outs, the auxiliary fuses or cut-outs in one series being arranged to connect the positive terminals of the dynamos to one of the conductors, and those in the other series to connect the negative terminals of the dynamos to the other of the conductors.



No. 490,992.—Electric Arc Lamp.

490,975. Electric Railway; Edward W. Mitchell, Covington, Ky. Application filed June 23, 1892. The combination with the insulated feed wire of the sectional service conductor consisting of a series of rigidly connected conducting sections insulated from each other and provided each with a series of contact posts adapted to make contact with the feed wire and service conductor, and retaining the posts normally out of contact with the feed wire in position to make contact therewith when pressure is exerted on the service conductor.

490,992. Electric Arc Lamp; James Sugden and Wallace J. L. Sandy, London, England. Application filed July 13, 1892. The combination in an electric arc lamp of a lower electromagnet having a spring supported armature to which the lower carbon is attached, with a closed air tube to which the upper carbon is attached, a roller at one side of the upper carbon and an electromagnet having an armature lever, the arm of which is located at the opposite side of the upper carbon and acts in connection with the roller as a brake to hold the upper carbon stationary. (See illustration.)

491,014. Trolley Wheel; John J. Goetz, Covington, and John A. Smith, Dayton, Ky. Application filed May 20, 1892. In a trolley device the combination with a bifurcated arm, the lower end of which is adapted to be secured to the trolley pole, and the upper end of each portion is perforated and provided with an outwardly facing recess around each perforation, a trolley wheel journaled in these perforations, the sides of which are each concave, rotary bearings around each end of the axle within its respective recess, and a cap for each recess, this cap being provided with three arms, the outer end of each of which projects into the concave portion of the wheel.

Copies of the specifications and drawings complete of any patent mentioned in this record—or of any other patent issued since 1886—can be had for 25 cents. Give date and number of patent desired and address The W. J. Johnston Co., Ltd., Times Building, N. Y.